KEMRON
ENVIRONMENTAL SERVICES

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February 3, 2014

Mr. Michael Mikulka
United States Environmental Protection Agency
77 West Jackson Boulevard
Mail Code: LU-9J
Chicago, IL 60604

Re: Restoration of Reach 1, of Dicks Creek, Monroe Ditch, and Outfall 002, Operation and Maintenance Plan, AK Steel Corporation, Middletown, Ohio; Revision 1, January 2014

Dear Mr. Mikulka:

On behalf of AK Steel Middletown Works, KEMRON Environmental Services, Inc. (KEMRON) submits the attached Revision 1 to the *Restoration of Reach 1, of Dicks Creek, Monroe Ditch, and Outfall 002, Operation and Maintenance Plan, AK Steel Corporation, Middletown, Ohio*. (O&M Plan). This O&M Plan was originally prepared by ENVIRON International Corporation, and was dated March 2009. The restoration of Dicks Creek Reach 1 was completed within the scope of the Year 2 Interim Measures work. Completion of the Year 2 work was documented in an Interim Measures Completion Report (KEMRON 2013), which received USEPA et al. acknowledgement of completion in a letter dated March 18, 2013. In accordance with the prior approved version of the O&M Plan, full implementation is thus scheduled to begin in calendar year 2014, since one full growing season has been completed since the restoration of Reach 1 was completed.

AK Steel, KEMRON and Biohabitats, as a subcontractor to KEMRON, have reviewed the O&M Plan in preparation for initiation of the full scope of the Year 1 O&M Plan monitoring. The plan has been revised to reflect that all the Interim Measures work referenced in the Plan was completed. A number of revisions have been identified as being appropriate to the O&M Plan, as outlined in the table attached to this correspondence. KEMRON initially identified in 2013 that the vegetation monitoring plots in some areas were not aligned with restored areas, creating a low bias for a significant portion of the vegetative monitoring plots. Additionally, the interpretation of certain performance criteria was unclear. Further, inconsistencies between the US Army Corps of Engineers Nationwide Permit 38 Ohio EPA Special Conditions and the O&M Plan were identified. KEMRON and Biohabitats met with OEPA to discuss suggested revisions to the 2009 approved O&M Plan on October 17, 2013. USEPA originally was scheduled to participate in this meeting, but was unable to do so due to the federal government shutdown that was in effect at the time. In that meeting, after discussion of key technical points, it was agreed that KEMRON and Biohabitats would submit a revised O&M Plan for USEPA et al. review and comment or approval. As agreed in the October meeting, all substantive revisions to the document are identified in the attached outline, with an explanation of the technical basis and reasoning for each revision.

Following USEPA et al. review of the enclosed outline of O&M Plan revisions and the revised O&M Plan, KEMRON and AK Steel request that any concerns or questions be discussed in a meeting or teleconference to provide the most expeditious resolution possible. This will allow open technical discourse and most timely resolution, to assure that 2014 and subsequent monitoring of the restored stream corridor provides consistent data that is representative of the conditions in the streams and floodplain.

Please feel free to contact Pat Gallo at (513) 425-3476, or me, at (740) 373-1266, if there are any questions regarding this submittal.

Sincerely,
KEMRON Environmental Services, Inc.

Mary Lou Rochotte, CPG, PMP
Senior Project Manager

ATTACHMENTS:
Dicks Creek Reach 1 and Monroe Ditch – Recommended Changes to O&M Plan Outline
O&M Plan Revision 1, January 2014

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This document outlines recommended changes to the existing O&M Plan stream and vegetation monitoring requirements established pursuant to the NWP38 issued for this project. Our recommended changes are based upon our review of the existing O&M Plan, a site assessment completed by KEMRON and Biohabitats, and discussions among KEMRON, AK Steel, Ohio EPA and Biohabitats. The figure illustrating the locations of monitoring (QHEI and FQAI areas) has been updated to reflect the text changes. The following summarizes the primary changes in the O&M Plan. The table below identifies NWP38 monitoring requirements, O&M Plan corresponding tasks as originally developed, our recommended changes, and rational for the changes to the O&M plan to more efficiently document permit compliance.

SUMMARY - SPECIFIC CHANGES TO O&M PLAN

Quality Habitat Evaluation Index (QHEI)

- Dicks Creek
  - Change from 6 original O&M QHEI locations to the following:
    - 1 site above the restoration reach
    - 1 site below the restoration reach
    - 3 existing Ohio EPA sites within the restoration reach
- Monroe Ditch
  - Change from 8 original O&M QHEI locations to the following:
    - 1 site above the restoration reach
    - 2 sites within the restoration reach

Walk-Through Inspections

- The majority of Reach 1 and all of Monroe Ditch were restored in 2010, and monthly walk through inspections have been conducted since that time. The portion of Reach 1 Dicks Creek that was restored in 2012 also has had a full year of walk through inspections performed. The O&M Plan is updated to include quarterly inspections for years 1 through 3 of the monitoring, with an unchanged semi-annual inspection schedule for years 4 and 5. The quarterly inspections will provide adequate seasonal observations and will be timed to provide adequate observation of emerging invasive species such that response to the invasives can be accomplished in a timely manner.

Vegetation Monitoring

- Adjust the O&M FQAI plots so they fall within restoration planting zones.
- Distribute plots to adequately assess forest and forest/meadow habitats. Add a road matrix if need be. Plot size will be the same size within a restoration reach, but overall they may vary between MD and DC.
- Plot size will be based on North Carolina's Stream Mitigation Monitoring Guidelines per their Ecosystem Enhancement Program, which indicates a minimum of 4 plots at 0.02 acres for a minimum of 2% of the areas planted

with woody vegetation.

- Assess vegetation within vegetation plots for % cover within each strata (include bare ground), species composition, richness, evenness, and woody stems per acre. Do not assess DBH and tree height.
- Change monitoring requirement to 400 stems per acre with 200 stems required to be trees.
- 80% of the woody cover within plots shall be native Ohio species.
- The lowest practicable level of invasive species % coverage should be 20% at year 5.
- Vegetation monitoring shall occur during the summer.

Sediment Monitoring

- Collect samples every 650 feet per the O&M Plan as originally approved instead of 400 feet.

Physical Measurements

- Provide additional clarity that the O&M Plan will utilize existing/planned as-built surveys for Year 1 Plan view geometry requirements.
- Based on the Stream Stability Ratings assessments, determine if plan view geometry measurements are necessary. If there are no significant changes to the plan view geometry, then measurements will not be necessary. However, if there are major changes to the plan view geometry, then physical measurements are required.
- Conduct longitudinal profiles within each 650 feet QHEI monitoring reach, two for MD and three for DC, as opposed to the entire project reach.

Sampling Timeline

- No change proposed. It is possible that AK Steel may request alignment of the Reach 1 and Reach 2 monitoring schedule in the future; however, no schedule change is recommended at this time.

The plan revisions also provide an option for AK Steel to request a reduction in the number of sampling locations for Year 5 O&M monitoring activities if the Year 3 data indicate that the performance criteria are met or exceeded. Any such reduction would be subject to submission for USEPA et al. review and approval.

The plan text overall has been updated to reflect that the remediation and restoration of Monroe Ditch and Dicks Creek Reach 1 have been completed. Text referencing various plans referenced in the document, including the DMP, QAPP and PIP, also have been updated to indicate the most current version of a particular plan will be used. Information on the environmental hotline has been incorporated into the public involvement section to assure this important tool for public input is noted.

Monitoring Criteria Streams

Monitoring Criteria	NWP38	O&M Plan	Recommended Changes	Rational for Changes
Walk through Inspections	Frequency not specified	Monthly in Year 1, Quarterly Years 2 and 3, Semi-Annually Years 4 and 5	Quarterly Years 1-3, Semi-annually Years 4 and 5	Monthly walk-throughs have been occurring for two full years in the Year 1 restoration area, and 1 full year in the Year 2, Reach 1 area. Quarterly frequency is now sufficient to observe significant changes and allow adequate response by AK Steel.
Stream Stability Rating	During Years 1, 3 & 5 visual observations to be noted in annual report and corrective actions taken.	Per permit requirement.	None	NA
Water Chemistry Monitoring	Grab samples in Years 1, 3 & 5 to analyze 14 parameters.	Per permit requirement.	None	NA
Sediment Monitoring	During Years 1, 3 & 5 collect sediment samples every 400 ft. & analyze for PCBs.	Samples collected every 650 linear feet.	Samples collected every 650 linear feet per O&M Plan	650 feet is the distance that was approved in the O&M Plan and also corresponds to the QHEI/ICI/IBI monitoring distances, providing consistent data for analysis.
Hydrology Monitoring	Collect water level data and estimated flow during wet and dry season of each monitoring year.	Per permit requirement.	None	NA

Monitoring Criteria Streams

Monitoring Criteria	NWP38	O&M Plan	Recommended Changes	Rational for Changes
Vegetation Monitoring	Identify plant communities & buffer area on drawing/aerial. Visually determine dominant plant species in each veg. layer of each community type.	Establish FQAI plots. Visual estimate & score of total tree canopy cover, ground cover among individual shrub species and all herbaceous vegetation. DBH for all living trees. Measure score of tree height. Identify & count all living tree species.	Adjust FQAI plots to reflect zones planted with woody species and account for a minimum of 2% of the areas planted with woody species. Identify species, measure % cover, and stems per acre (400 stems per acre w/200 being trees). Plot sizes for MD shall all be the same size. Plot sizes for DC shall all be the same size. Plots should adequately represent forest and forest/meadow habitats. Based on North Carolina's Stream Mitigation Monitoring Guidelines from their Ecosystem Enhancement Program, vegetation monitoring should include a minimum of four 0.02 acre plots, encompassing at least 2% of the planted area. Using the six existing plots at 0.02 acres each, the percentage of DC that will be monitoring is 5.2% and 8.7% for MD. Richness and evenness will also be documented.	Many of the FQAI plots fall outside areas that were planted and/or include areas that were not planted with woody and/or tree species. Based on the growing conditions, DBH & tree height are not good measures/metrics of success. Stems/acre will better assess overall survival & success and capture voluntary recruitment of woody species occurring at the site. Several stream mitigation monitoring documents indicate that survey plots shall make up a minimum of 2% of the planted portion of the site. These include North Carolina's Ecosystem Enhancement Program and "Monitoring the Effectiveness of Riparian Vegetation Restoration" from the University of California's Center for Forestry.

Monitoring Criteria Streams

Monitoring Criteria	NWP38	O&M Plan	Recommended Changes	Rational for Changes
Quality Habitat Evaluation Index (QHEI)	Conduct QHEI assessments in each monitoring year.	QHEIs conducted every ~650 linear feet. 3,000 lf of Monroe Ditch includes 8 QHEIs and 3,000 lf of Dicks Creek includes 6 QHEIs.	Monroe Ditch: Conduct a QHEI (650 lf reach per QHEI Manuel for wadeable stream), above the project reach and 2 QHEIs within the restored reach. Dicks Creek: Conduct a QHEI (650 lf reach) above and below the project reach and 3 within the restored reach at the 3 historic QHEI locations.	Representative QHEIs are proposed instead of sampling the entirety of both project reaches. Both reaches will now have above and below QHEIs and sampling covering 43% of the restored Monroe Ditch and 65% of the restored Dicks Creek.
Invertebrate Community Index (ICI)	Conduct macroinvertebrate sampling in each monitoring year.	Collect data at locations identified for stream habitat surveys.	ICI locations same as QHEI locations within project reach.	NA
Index of Biotic Integrity (IBI)	Conduct fish sampling in each monitoring year.	Collect data over 200 meter electrofishing zones.	IBI locations same as QHEI locations within project reach.	NA

Performance Criteria - Streams

Performance Criteria	NWP38 Criteria	O&M Plan Response If Failure to Meet after 5 years	Recommended Changes	Rational for Changes
#1	Within 5 years develop QHEI, ICI & IBI scores at or exceeding the greater of pre-remediation values or upstream values.	Extend monitoring period and/or contingency maintenance actions.	NA	NA
#2	Develop a native upland buffer as measured from the top of the bank.	Extend monitoring period and/or contingency maintenance actions.	NA	NA
#3	Develop 80% native Ohio woody cover in the riparian zone.	Extend monitoring period and/or contingency maintenance actions.	It was clarified with Ohio EPA that the 80% nativity was species composition	NA
#4	Achieve no more than 5% invasive species coverage in the 1st 2 years & keep invasives at the lowest level practicable during the remaining 3 years.	Extend monitoring period and/or contingency maintenance actions.	Clarify what "lowest level practicable" means, very subjective. Recommend 20%.	Recommend 20% as lowest level practicable given adjacent sources and previous requirement for 80% cover native woody species. 20% was listed in a permit for a 2010 stream restoration project we did in NE Ohio.
#5	Channel and banks shall be stable & show no signs of excessive problems.	Extend monitoring period and/or contingency maintenance actions.	NA	NA

Reporting Requirements

Reporting Categories	NWP38	O&M Plan	Recommended Changes	Rational for Changes
Physical Measurements (Streams) A.	Plan view geometry measurements taken to include measurements necessary to determine sinuosity, meander wavelength, belt width, radius of curvature & meander arc length for a min. of 2 meander bends.	Per requirements.	We propose to use the existing/planned as-built survey (post construction) as a baseline for Physical Measurements for Year 1 monitoring. Based on monitoring for the Stream Stability Rating, if no physical changes to the stream are observed, then we re-submit the Year 1 as-built. If major changes to the stream are observed during year 3 and/or 5, then a survey will be conducted in that respective year.	Plan view geometry features are very limited within both project reaches. Based on the Stream Stability Rating monitoring that is occurring, any changes in plan view geometry will be observed and noted. If major changes to the plan view geometry are noted, the plan view geometry measurements will be taken through a survey. However, if no major plan view geometry changes are observed then a survey won't provide any new data as compared to the tremendous investment in time and money based on the extensive length of both project reaches.
Physical Measurements (Streams) B.	During each monitoring year take a plan view geometry, longitudinal profile and cross section.	Per requirements.	Recommend, as per above, that plan view geometry will be addressed in the Year 1 as-built survey. Longitudinal profiles to be conducted within proposed QHEI reaches, as opposed to the entire length of restoration. See below for	See rational above for plan view geometry and below for longitudinal profile.

			cross section.	
Reporting Categories	**NWP38**	**O&M Plan**	**Recommended Changes**	**Rational for Changes**
Physical Measurements (Streams) C.	Cross Sections: Collected over full width of stream with at least 1 pool and 1 riffle section. Include bankfull width, bankfull max. depth, flood prone area width, entrenchment ratio, bankfull x-sectional area & bank height. Longitudinal Profiles: Include measurements necessary to determine average water surface slope, riffle slope, pool slope, & riffle/pool sequences. Provide elevation for thalweg, water surface & bankfull stage.	Per requirements.	Cross Sections: None Longitudinal Profiles: As per above, recommend conducting longitudinal profiles within proposed QHEI reaches, as opposed to entire length of restoration. Monroe Ditch to include two 650-feet longitudinal profiles and Dicks Creek would include three 650-feet longitudinal profiles.	Based on the limited plan view geometry features, similar riffle/pool complexes throughout the project reaches, and extensive lengths of the project reaches; conducting longitudinal profiles within the QHEI reaches will adequately represent that physical measurement for the project. Approximately 65% of the length of Dicks Creek will be measured and approximately 43% of the length of Monroe Ditch.

RESTORATION of REACH 1 of DICKS CREEK, MONROE DITCH, and OUTFALL 002 OPERATION AND MAINTENANCE PLAN

AK Steel Corporation
Middletown, Ohio

Revision 1

Prepared for:

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March 2009

Revision 1: January 2014

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Acronyms

DBH	Diameter at breast height
DMP	Data Management Plan
FQAI	Floristic Quality Assessment Index
GPS	Global Positioning System
HASP	Health & Safety Plan
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IM SOW	Interim Measures Scope of Work
MIwb	Modified Index of Well-Being
NRDC	Natural Resources Defense Council
OAC	Ohio Administrative Code
O&M	Operation and Maintenance
Ohio DNR	Ohio Department of Natural Resources
Ohio EPA	Ohio Environmental Protection Agency
PCBs	Polychlorinated biphenyls
QAPP	Quality Assurance Project Plan
QHEI	Qualitative Habitat Evaluation Index
SOP	Standard operating procedure
WQS	Water Quality Standards

1.0 INTRODUCTION

This *Restoration of Reach 1 of Dicks Creek, Monroe Ditch, and Outfall 002 Operation and Maintenance* (O&M) *Plan* addresses the procedures for the inspection and maintenance of the restored channel and floodplain of Reach 1 of Dicks Creek, the restored channel of Monroe Ditch (from the railroad culvert to the existing concrete liner), and the restored Outfall 002 channel described in Interim Measure 8 of the Consent Decree (Attachment 1, Interim Measures Scope of Work [IM SOW]) signed by USEPA et al. (i.e., United States Environmental Protection Agency, State of Ohio, Sierra Club, and Natural Resources Defense Council [NRDC]) and AK Steel (Case No. C-100530) and entered on May 15, 2006. This O&M plan was originally prepared by ENVIRON International Corporation, and the March 2009 version was approved from implementation. This Revision 1 to the O&M Plan provides updates based on work completed in Dicks Creek and Monroe Ditch in the intervening years, and revises monitoring locations and methods to be consistent with current relevant guidance and the final restored areas that were implemented in Dicks Creek and Monroe Ditch during Interim Measures implementation.

The monitoring established by this O&M Plan is scheduled to be fully implemented following the completion of the restoration of Dicks Creek Reach 1 and Monroe Ditch. The O&M monitoring will begin in the first full year after the end of the first full growing season following completion of restoration. Based on all restoration having been completed in the stream segments addressed in this O&M Plan in late calendar year 2012, calendar year 2014 will be Year 1 of the full implementation of this O&M Plan.

The mitigation designs for the restored portions of Dicks Creek Reach 1 and Monroe Ditch were detailed in the *MDA-33S, Monroe Ditch, and Dicks Creek Reach 1 Sediment and Floodplain Soil Remediation Design Document* and the *Dicks Creek Year 2 Dicks Creek Sediment and Floodplain Soil Remediation Design Document*. USEPA et al. acknowledged completion of the Restoration of these stream segments in correspondence dated June 13, 2011 and March 18, 2013.

The scope of this O&M plan encompasses: (1) the scheduled inspection, evaluation, and documentation of the status of the newly restored segments of Reach 1 of Dicks Creek and Monroe Ditch; and (2) any necessary contingency maintenance actions.

The primary objectives of this O&M plan are to provide systematic evaluations of Interim Measure 8 through:

- Inspections of Reach 1 of Dicks Creek and Monroe Ditch for evidence of threats or damage to plantings, stream channel and bank erosion, and failure of engineered or constructed stream control measures;
- Investigations of the channel morphology of the two restored segments and of the floodplain development of Reach 1 of Dicks Creek;
- Revegetation surveys;

- Stream habitat surveys and aquatic biological assessments of Reach 1 of Dicks Creek and Monroe Ditch; and
- Performance of any necessary contingency maintenance actions (e.g., non-native invasive plant treatments, additional installation of native plants, erosion control) to ensure that the restoration of Reach 1 of Dicks Creek and Monroe Ditch reaches the goals set in the design document.

All field personnel will have reviewed this O&M plan before conducting inspections or contingency maintenance actions governed by this plan.

2.0 PROJECT BACKGROUND

2.1 General Project Area

Dicks Creek is a small, partially channelized stream draining an urbanized and industrialized watershed (Figure 1). Dicks Creek is located to the south and east of Middletown, Ohio, in Butler and Warren Counties. A portion of Dicks Creek flows between the AK Steel Middletown Works facility and the slag processing area leased to and operated by Tube City IMS and owned by AK Steel. Dicks Creek originates to the east of Middletown and flows westward toward its confluence with the Great Miami River. The Dicks Creek watershed extends approximately 12 miles east of the Great Miami River and encompasses an area of approximately 50 square miles. Significant tributaries include the North Branch of Dicks Creek (which flows from north to south adjacent to the AK Steel facility before joining the main branch of Dicks Creek), Shaker Creek, and Miller's Creek (which flows into Shaker Creek a short distance upstream of its confluence with Dicks Creek). AK Steel owns the land surrounding and underlying those portions of Dicks Creek between approximately river mile 2.5 and 5.6. For remediation planning purposes, two reaches are designated in Dicks Creek. Reach 1 includes the channelized portion of the creek on and near AK Steel Middletown Works property, extending from approximately 50 feet upstream of Outfall 002 to approximately 400 feet downstream of Yankee Road. Reach 2 is primarily non-channelized and extends from the downstream end of Reach 1 to approximately 300 feet downstream of the Main Street Bridge in Middletown. Reach 1 of Dicks Creek was channelized circa 1967 for flood control purposes.

A small tributary, known locally as Monroe Ditch, traverses the southwestern portion of the slag processing area and drains into Dicks Creek (Figure 1). Monroe Ditch enters the southwestern portion of the slag processing area through three culvert pipes that run beneath railroad tracks near the southern property line. The ditch is typically approximately 10 feet wide with 3 to 6 inches of water. A small portion of the ditch was rerouted during development of the slag processing area in the 1970s. The portion of Monroe Ditch located on AK Steel property is now bounded by closed solid waste landfills.

Concerns were first raised regarding polychlorinated biphenyls (PCBs) in Dicks Creek in 1995 after the Ohio Environmental Protection Agency (Ohio EPA) detected PCBs in sediment in Dicks Creek (Ohio EPA, 1997). Subsequent investigations have detected PCBs in floodplain soil of Reach 1 of Dicks Creek and sediment in Monroe Ditch (from the railroad culvert to the concrete liner). The Consent Decree requires that AK Steel excavate and properly dispose of all sediment, as well as underlying clay or other native material where PCBs have been detected at concentrations exceeding applicable cleanup standards in Monroe Ditch, the Outfall 002 channel, and Reach 1 of Dicks Creek.

Interim Measure (IM) 6 encompasses the excavation and proper disposal of contaminated material from these areas. Interim Measure 8 encompasses the restoration of these areas following the remediation of the areas. Restoration of the stream segments was conducted concurrently with or after the completion of Interim Measure 6, as described in the Year 1 and Year 2 Interim Measures Completion Reports (ENVIRON 2011; KEMRON 2013).

2.2 Restoration of Dicks Creek, Monroe Ditch, and the Outfall 002 Channel

Interim Measure 8 requires:

- Installation of rip-rap in the Outfall 002 channel;
- Restoration of Reach 1 of Dicks Creek with clean sand, gravel, and cobbles, as appropriate, to minimize channel incision and restore biological productivity to the maximum extent possible; and
- Restoration of Monroe Ditch, from the railroad culvert to the existing concrete liner, in order to limit movement of contaminants from the adjacent areas, minimize channel incision, and restore biological productivity to the maximum extent possible.

Interim Measure 8 also requires that, at least 1 foot of clean material be placed in areas where 1 or more feet of sediment have been removed from Dicks Creek Reach 1. With regard to Monroe Ditch, Interim Measure 8 considers: (1) the containment and recovery of free product and the treatment of PCBs in groundwater in the vicinity of Monitoring Well MDA-33S (Interim Measure 3); and (2) the restoration of the stream's biological habitat, including stream substrate restoration through the placement of clean sand, gravel, and cobbles, the prevention of channel incision, the implementation of measures to minimize down-cutting or under-cutting of the stream upstream and downstream of the area undergoing remediation, the establishment of a floodplain/floodway, and the implementation of other riparian restoration measures.

2.2.1 SWMUs 38 and 39

The remediation of Reach 1 of Dicks Creek required the removal of all sediment from the channel and a significant portion of the floodplain and the rebuilding of a new channel and floodplain. The restoration approach for Reach 1 of Dicks Creek included: (1) the imposition of a more sinuous shape on a shallower channel; and (2) the partial rebuilding of the floodplain. Clean sand, gravel, and/or cobbles were placed, as appropriate, in the stream's post-remediation channel and floodplain as planned in the restoration design and illustrated in the final as-built drawings contained within the Completion Reports for the work. The restoration was also designed to make use of natural sedimentation processes to complete the rebuilding of the channel and floodplain.

This approach included the placement of engineered structures (e.g., rock toe protection structures) to stabilize the bank at key points and form a more sinuous channel shape that will act as a template for the restored channel. The restoration also included the installation of floodplain weir riffles that traverse the entire floodplain. The weirs were designed to increase and guide the deposition of sediment onto the floodplain and to provide larger-sized material for riffle habitat in the channel. In addition, large woody-debris structures were placed in the floodplain to aid deposition and improve aquatic habitat.

Other measures also were used to restore the biological productivity of Reach 1 to pre-remediation conditions. These measures included the: (1) installation of live stakes in wetter depositional areas; (2) planting of containerized trees and shrubs higher up on the edges of the

floodplain and berm; and (3) treatment of non-native invasive plant species on those areas of the floodplain not addressed in the remediation, to the extent practicable. Installing native vegetation immediately after construction provides these plants the opportunity to become established before nearby invasive species re-colonize the area. However, given the abundance of non-native invasive plant species in the surrounding area, some colonization by non-native species over time is unavoidable. On-going control of invasive species is discussed additionally in Section 3.

2.2.2 Monroe Ditch

The remediation of the segment of Monroe Ditch from the railroad culvert to the concrete liner consisted of the removal of all sediment from the existing bed of the channel (this section of the ditch does not have a natural floodplain). The restoration included rebuilding the channel of Monroe Ditch with constructed riffles and pools and slightly increasing the channel's sinuosity where possible. In addition, other structures (e.g., rootwad and large woody debris structures) were installed in the channel for bank protection and in-stream habitat improvement.

Other measures used to restore the biological productivity of Monroe Ditch included: (1) treatment of non-native invasive plant species, to the extent practicable; and (2) installation of containerized trees and shrubs along the stream.

2.2.3 The 002 Outfall Channel

The remediation of the 002 Outfall channel included the excavation and removal of contaminated sediment from the bed of the outfall's channel. The restoration of the 002 Outfall channel was completed with the placement of rip-rap in the channel to restore it to pre-remediation grade.

3.0 MITIGATION MONITORING PROCEDURES

An active operation and maintenance program for the mitigated and restored segments of Reach 1 of Dicks Creek and Monroe Ditch is established in this plan to ensure that the specific goals set forth in the design documents regarding these stream segments are met. Inspections and monitoring of the restored segments will be used to initiate any necessary contingency (i.e., maintenance) activities and to verify that the goals of the restoration have been met over the long-term. The inspections and monitoring will be conducted for a period of 5 years. The specific operation procedures are described below. Contingency maintenance procedures are discussed in Section 5.0.

Several tasks will be periodically conducted as part of the inspection and monitoring operation procedures including the: (1) walk-through inspections of the restored segments of Reach 1 of Dicks Creek and Monroe Ditch; (2) evaluation of channel morphology and floodplain development; (3); stream sampling and monitoring; and (4) biological monitoring of the two restored segments (including revegetation surveys).

3.1 Walk-Through Inspections

Walk-through inspections have been conducted monthly since the completion of the restoration of Reach 1 of Dicks Creek and Monroe Ditch. Monroe Ditch and the majority of Reach 1 were restored in 2010; thus, monthly inspections have spanned several years in this stream segment. The segment of Reach 1 that was restored in 2012 has been monitored through monthly walk-through inspections since early 2013. Therefore, it is proposed that walk-through inspections be conducted quarterly in the first full year of monitoring (2014) through Year 3, with semi-annual inspections to be conducted in Years 4 and 5. If unusual circumstances are identified in any regularly scheduled inspection, additional site visits to the affected area may be completed prior to the following scheduled inspection to determine whether contingency measures are necessary. However, quarterly inspections in monitoring Years 1 through 3 are anticipated to provide adequate assessment of restoration conditions based on all trees and shrubs having had a full year to establish adequate root mass.

The purpose of walk-through inspections is to identify any obvious changes to Reach 1 of Dicks Creek and Monroe Ditch and any obvious threats or damage to native species plantings so that they can be addressed in a timely manner through contingency maintenance actions (if deemed necessary). During each walk-through inspection, inspectors will traverse Reach 1 of Dicks Creek and the restored segment of Monroe Ditch in order to document the condition of the channels and floodplains and the composition and growth of the riparian vegetation. Conducting the walk-through inspections at least quarterly for the first three years will assure seasonal observations, and will be timed to provide observation of any emerging invasive species that require action during the same growing season. Notes on locations of interest will be determined using a Global Positioning System (GPS) unit (SOP 1024 [Appendix C]).

During the inspection, the inspector(s) will document:

- Evidence of meso-scale channel incision or aggradation;
- Evidence that natural stream processes are completing the construction (through sedimentation) of the floodplain of Dicks Creek as designed;
- Evidence of failed engineered or constructed stream and floodplain control measures (e.g., floodplain weirs, riffles, revetments);
- Presence, location, and apparent or likely cause of eroded or unstable banks (e.g., inadequate or failing stabilization/erosion control structures, flood damage);
- Presence, location, and apparent or likely cause of general vegetation establishment failures (e.g., flood damage, disease, pests, drought); and
- Noteworthy presence of crowding/choking weeds and invasive species (Appendix B).

The walk-through inspections will also document any evidence of large-scale catastrophic failures of the restoration. If a catastrophic failure is determined to be occurring, appropriate contingency maintenance actions will be taken after consultation with USEPA et al.

The results of the walk-through inspections will be recorded on Walk-Through Inspection Log Sheets (Appendix A) and will be summarized in an annual mitigation monitoring report that will be prepared for each of the 5 monitoring years. Any obvious change to Reach 1 of Dicks Creek or Monroe Ditch and any obvious threats or damage to native species plantings will be discussed in the report. Actions taken each year to assess and remove/control invasive species will be included in the annual report. Necessary or emergency contingency actions will be conducted after approval by AK Steel and will be discussed in the annual report.

3.2 Channel and Floodplain Morphology Evaluation

The channel morphology of Reach 1 of Dicks Creek and Monroe Ditch and the development of the floodplain of Reach 1 of Dicks Creek will be evaluated in Years 1, 3, and 5 following the restoration of these two streams through thalweg, channel bank, and floodplain surveys. A survey of the two streams was conducted following completion of the restoration (i.e., the Year 1 and Year 2, Reach 1 as-built, initial surveys). The results of the Year 1 initial surveys will be compared to subsequent surveys conducted in Years 3 and 5 of the O&M monitoring to evaluate (1) the stability of Reach 1 of Dicks Creek and Monroe Ditch (changing morphology); and (2) the building of the floodplain of Reach 1 of Dicks Creek through natural sedimentation processes. The results of the Year 1 and Year 2, Reach 1 initial surveys provided in the as-built drawings of the Completion Reports will serve as a baseline for Physical Measurements for future monitoring.

The survey components include measuring the location and elevation of a sufficient number of survey points to construct: (1) plan view maps; (2) longitudinal profiles; and (3) cross sections of the two restored segments. The surveys will be conducted during the same approximate time of year, preferably when discharge is generally low (June 15th to September 15th) by a surveyor licensed in the State of Ohio. The surveys are included in the completion reports submitted and approved for the Year 1 and Year 2, Reach 1 Dicks Creek and Monroe Ditch remediation projects.

3.2.1 SWMUs 38 and 39

Based on monitoring of the Stream Stability Rating, if no physical changes are observed during a given monitoring year, the Year 1 as-built survey will be re-submitted as opposed to conducting a new survey in Year 3 and/or 5 respectively. The basis of the Stream Stability Rating will be reported in the annual mitigation report, regardless of the need for surveying in the given year.

If a survey is required the surveyor will measure the location of a sufficient number of survey points to construct accurate plan view maps showing the floodplain and channel of the two restored segments. From these maps the sinuosity, meander wavelength, meander belt width, radius of curvature of individual meanders, and meander arc length can be calculated. A comparison of the Year 1 results with subsequent surveys, if determined necessary, combined with the Stream Stability Rating will provide an indication of whether the channel and/or floodplain are eroding or whether they are stable.

3.2.2 Longitudinal Profiles

The surveyor will measure the elevation and location of a sufficient number of survey points along the thalweg of Reach 1 of Dicks Creek and Monroe Ditch within the Qualitative Habitat Evaluation Index (QHEI) reaches (see Section 3.4.2) to construct longitudinal profiles of the QHEI reaches of the two restored segments. The surveyor will obtain measurements as necessary to evaluate average water-surface slope, riffle slope, pool slope, and riffle/pool or step/pool sequences. A comparison of the as-built longitudinal profiles of Reach 1 of Dicks Creek and Monroe Ditch to their longitudinal profiles in Years 3 and 5 will provide an indication of whether the two restored channel segments are degrading or aggrading their beds or whether they are stable.

3.2.3 Cross Sections

Cross sections will be constructed using the location and elevation of sufficient number of survey points on the floodplains, on the channel banks, and in the channel (including the thalweg) to construct cross sections across a section of Reach 1 of Dicks Creek and a section of Monroe Ditch. The minimum length of each section will be equivalent to the distance occupied by 30 times each stream's bankfull width. In each section of both streams, there will be two permanent cross section locations (i.e., the same two locations will be used in Years 1, 3, and 5). In addition, in each section of both streams, one cross section will be through a pool and another cross section will be through a riffle. All cross sections will include: bankfull width; bankfull maximum depth, flood-prone area width, entrenchment ratio, bankfull cross-sectional area, and bank height. A comparison of the Year 1 cross sections with Year 3 and 5 cross sections will provide an indication of whether (1) the channels are incising or aggrading or whether they are stable and (2) channel banks and floodplain are eroding or whether they are stable.

The results of each evaluation will be presented in the corresponding annual mitigation monitoring report.

3.3 Stream Sampling and Monitoring

Several types of sampling and monitoring will be conducted annually after completion of the restoration of Reach 1 of Dicks Creek and Monroe Ditch including: (1) surface water sampling; (2) sediment sampling; and (3) hydrology monitoring. The results of sampling and monitoring will be presented in the corresponding annual mitigation monitoring report.

3.3.1 Surface Water Sampling

Samples of surface water will be collected from Reach 1 of Dicks Creek and Monroe Ditch at points located every 400 linear feet along each stream. The samples will be collected between June 1 and October 1 of each year and analyzed for:

- Ammonia
- Nitrates
- Nitrite
- Carbon
- Total Sulfates
- Total Iron
- Total Manganese
- Specific Conductivity
- pH
- PCBs – only if the pH of the water exceeds 9.0
- Temperature
- Turbidity
- Total Suspended Solids
- Heavy Metals
- Biochemical Oxygen Demand

3.3.2 Sediment Sampling

Sediment samples will be collected one time each in Years 1, 3, and 5 from Reach 1 of Dicks Creek and Monroe Ditch at points located approximately every 650 linear feet along each stream and analyzed for PCBs. Exact locations may need to shift slightly based on locations of stream features and sediment deposition within the stream bed.

3.3.3 Hydrology Monitoring

Water level data and estimated flow will be collected once during the wet season (March 15th to May 15th) and once during the dry season (June 15th to September 15th) of Years 1 through 5. Depth to groundwater in adjacent monitoring wells will be measured in the absence of surface water.

3.4 Biological Monitoring

Biological monitoring will consist of: (1) revegetation surveys; (2) stream habitat surveys; and (3) aquatic biological assessments. The results of the biological monitoring will be presented in the corresponding annual mitigation monitoring report.

3.4.1 Revegetation Survey

Following the completion of planting activities, revegetation surveys will take place at roughly the same time of year to: (1) examine the health and development of the plantings; and (2) recognize and address any potential problems (e.g., invasive species, disease) through contingency maintenance actions. Summer is expected to be the best time of year to conduct these surveys, for comparability with pre-remediation baseline data. Revegetation surveys will be conducted in Years 1, 3, and 5.

The revegetation surveys will be conducted at six permanent 0.02 acre survey plots (referred to as floristic quality assessment index [FQAI] areas) established on Reach 1 of Dicks Creek and at six permanent 0.02 acre FQAI areas established along Monroe Ditch (Figure 1). FQAI areas established along Reach 1 of Dicks Creek will be designated DC1 through DC6 (east to west), totaling approximately 5.2% of the overall planted restoration area, and restoration FQAI areas established along Monroe Ditch will be designated MD1 through MD6 (south to north), totaling approximately 8.7% of the overall planted area. These areas are intended to be representative of the revegetation, encompassing at least 2% of the total area planted per stream mitigation monitoring guidelines from the North Carolina Ecosystem Enhancement Program, which modifies the 2003 USACE Stream Mitigation Guidelines. The vegetation plots will be inclusive of the planting zones (i.e., primary bank, lower terrace, upper bank, saturated zones on Dicks Creek) that were planted with woody vegetation during the Year 1 and Year 2 restoration work. The corners of each plot will be identified using semi-permanent markers/stakes and the locations will be determined using a GPS unit (SOP 1024 [Appendix C]). Additionally, all trees within each area will be identified to species and flagged/tagged to facilitate the surveys. Percent cover within each strata, species composition, richness, evenness, and woody stems per acre will all be used as indicators of revegetation success. Because remediation activities will create conditions that favor native plants as well, volunteer species will also be monitored. In addition, the entire length of the restored segments will be photographed to document the progression of the revegetation (i.e., growth/succession of vegetation, bank transformation) beyond the FQAI areas. These measures will: (1) reveal emerging trends within the revegetation (e.g., survival, growth, competition); and (2) help determine whether contingency maintenance actions may be necessary (Section 4).

<u>FQAI Areas</u>

Quantitative and qualitative data will be used to assess the overall growth of trees and shrubs within each area. Data will be documented within Revegetation Log Sheets (Appendix A). Within each area, inspectors will determine the following:

- Visual estimate and score of total tree canopy cover (i.e., 0 [no cover]; 1 [>0 – 20% cover]; 2 [>20 – 40% cover]; 3 [>40 – 60% cover]; 4 [>60 – 80% cover]; and 5 [>80 – 100% cover]);
- Visual estimate and score of ground cover among individual shrub species and all herbaceous vegetation (i.e., 0 [no cover]; 1 [>0 – 20% cover]; 2 [>20 – 40% cover]; 3 [>40 – 60% cover]; 4 [>60 – 80% cover]; and 5 [>80 – 100% cover]);
- Identity and count of all living woody species;
- Richness (number of woody species);
- Evenness (relative abundances of the different woody species);
- Tree stems per acre; and,
- Shrub stems per acre.

Photo documentation

The progression of the revegetation (i.e., growth/succession of riparian vegetation, bank transformation) will be photo-documented from various points along Dicks Creek and Monroe Ditch. Beginning at one end of each restored segment, the photographer will direct the camera perpendicular to the creek or ditch and capture an image of that portion of the floodplain. The photographer will traverse the restored segments and collect additional photographs such that images along the entire length of the creek and ditch will be documented. Photograph locations will be determined using GPS (SOP 1024 [Appendix C]) so that the locations can be revisited in the subsequent years for annual documentation.

The results of each revegetation survey will be presented in the annual mitigation monitoring report. Survey results will be interpreted in the report to compare growth rates among species and determine how cover, composition, density, and frequency are reflected in plant growth/mortality. This information will also be valuable if replanting is necessary, so that any replanting efforts can use the most successful species and planting densities. Photographs taken during the survey will be included in the report. Contingency actions will be conducted following approval by United States et al. and will be documented in the annual mitigation monitoring report.

3.4.2 Stream Habitat Survey

Aquatic habitat quality will be assessed using standard Ohio EPA methods to determine the Qualitative Habitat Evaluation Index (QHEI [Ohio EPA 1989a]). The QHEI surveys will be conducted by a Level 2 or Level 3 Qualified Data Collector, as certified by Ohio EPA. Surveys will be conducted at specific locations along Reach 1 of Dicks Creek and the restored segment of Monroe Ditch. Approximate sampling zones for Reach 1 of Dicks Creek will include one site above and one site below the restored reach, as well as the three historic QHEI locations within the restored reach. Approximate sampling zones for Monroe Ditch will include one site above the restored segment and two sites within the restored segment. The locations are illustrated on Figure 1. Actual sample locations will be recorded using a GPS unit.

Stream habitat surveys will be conducted in Years 1, 3, and 5 and will be conducted concurrently with the aquatic biological assessment described below (Section 3.4.3).

3.4.3 Aquatic Biological Assessment

An aquatic biological assessment will be conducted in Years 1, 3, and 5. The assessment will be conducted in accordance with standard Ohio EPA methods (Ohio EPA 1988a, b; 1989a, b) by a certified Level 3 Qualified Data Collector. The assessment will include sampling fish and aquatic macroinvertebrate communities at the QHEI locations along Reach 1 of Dicks Creek (3) and the restored segment of Monroe Ditch (2) identified for the stream habitat surveys, see Section 3.4.2.

Aquatic biological assessment components will include the following:

- Fish sampling will be conducted over 200-meter electrofishing zones/QHEI locations. Results will be used to calculate the Index of Biotic Integrity (IBI) for all sampling zones and the Modified Index of Well-Being (MIwb) where applicable (i.e., excluding "headwaters" locations).
- Macroinvertebrates will be collected using Hester-Dendy artificial substrate samplers and standard qualitative sampling methods, at sample locations within the QHEI reaches where current velocity is at least 0.3 feet per second under normal conditions. Sampling results will be used to calculate the Invertebrate Community Index (ICI). At locations where the Dicks Creek flood model or field observations indicate that the minimum current velocity for Hester-Dendy sampling is not met (if any), only qualitative sampling will be conducted.
- A visual assessment of physical habitat conditions will be used to determine the Qualitative Habitat Evaluation Index (QHEI) for each fish sampling zone (Section 3.4.2).

All biological index scores will be compared to pre-remediation values and Ohio Water Quality Standards (WQS) biocriteria (Chapter 3745-1-07 of the Ohio Administrative Code [OAC]). If the biological indices and QHEI values calculated for Reach 1 of Dicks Creek and Monroe Ditch do not meet or exceed their pre-remediation values, then contingency maintenance procedures may be required (Section 5).

The results of each aquatic biological assessment will be summarized and discussed in the annual mitigation monitoring report in conformance with the OEPA special conditions within the US Army Corps of Engineers Nationwide Permit 38 issued for the Dicks Creek Reach 1 remediation and mitigation. The report will include any recommendations for contingency maintenance actions as necessary. The appropriate response to the failure of the restoration to meet or exceed pre-remediation IBI and QHEI values will be determined in consultation with United States et al.

4.0 BIOLOGICAL PERFORMANCE CRITERIA

Within five years after completion of the restoration of Reach 1 of Dicks Creek and Monroe Ditch, the restored segments will meet the following performance criteria:

1. Obtain QHEI, ICI, and IBI scores at or exceeding the greater of the following: pre-construction value or upstream (undisturbed area) value;
2. Develop a native upland buffer as measured from the top of the bank with 400 woody stems per acres (200 shrubs and 200 trees)
3. Develop 80 percent native Ohio woody species composition in the riparian zone
4. Allow no more than five percent invasive species coverage in the first two years and continue maintenance to keep invasive species at the lowest level practicable (20%) during the remaining three years; and
5. Maintain the stability of stream's restoration (mitigation) channels and banks (upstream and downstream) and show no signs of excessive bank erosion, sedimentation, headcutting, aggradation, entrenchment, or degradation.

If the restored segments of Reach 1 of Dicks Creek and Monroe Ditch do not meet the performance criteria above, the post-restoration monitoring period may have to be extended and/or contingency maintenance actions may have to be conducted. The appropriate contingency maintenance action will be determined in consultation with United States et al.

If the measurements from the Year 3 monitoring period indicate that the mitigated, restored areas meet or exceed the performance criteria, AK Steel may request a reduction in the number of monitored areas for portions of the O&M monitoring to be performed during Year 5, for review and approval by United States et al.

5.0 CONTINGENCY MAINTENANCE ACTION

The remediation of Reach 1 of Dicks Creek included the removal of all sediment from the channel and from a significant portion of the floodplain. The remediation of Monroe Ditch required the removal of all sediment from the bed of the stream. The restoration of Reach 1 of Dicks Creek required the rebuilding of a new channel and floodplain, and the restoration of Monroe Ditch included rebuilding the channel of the stream. The remediation areas are fully described and illustrated in the Year 1 and Year 2 Dicks Creek and Monroe Ditch Sediment and Floodplain Soil Interim Measures Completion Reports as submitted to and approved by United States et al. (ENVIRON, 2011; KEMRON, 2013). Contingency actions will be implemented in the event that the inspection, evaluation, and/or survey data indicate that maintenance activities are needed to meet restoration goals.

Contingency maintenance actions will be required to address significant restoration failures, to the extent practicable. The effect of contingency maintenance actions will be assessed by continuing the inspections, evaluations, and surveys and by other monitoring actions undertaken to evaluate the restoration over a period of 5 years. Restoration failures may include:

- Significant erosion or instability of the channel bank of Reach 1 of Dicks Creek and/or Monroe Ditch;
- Significant aggradation or degradation of the channels of Reach 1 of Dicks Creek and/or Monroe Ditch;
- Failure of engineered or constructed stream control measures (e.g., riffle/weir structures);
- Various types of revegetation failures (e.g., poor vegetative cover or dominance of non-native invasive species); and
- Failure to meet a QHEI, ICI, and/or IBI performance criteria.

Contingency maintenance actions taken to address restoration failures could include: (1) replanting those areas identified as having a revegetation failure; (2) controlling or removing weeds, to the extent practicable; (3) stabilizing channel beds, banks, and floodplain areas identified as unstable or eroding; and/or (4) repairing or replacing failing engineered or constructed stream control measures. However, some elements of the Dicks Creek Reach 1 restoration design are not required under the Consent Decree and are being implemented voluntarily by AK Steel. Also, while the restoration is designed to minimize down-cutting and under-cutting that would result in channel bed and bank erosion, prevention of all erosion may not be feasible due to watershed-scale conditions, normal channel adjustment following restoration, and the ongoing channel instability and erosion upstream of the project.

The revegetation design intentionally incorporated over-planting, such that the loss of some individual plants is expected. Indeed, the density of large trees in the pre-remediation Reach 2 forested riparian corridor is less than 25% of the initial planting density of the restoration design (ARCADIS G&M, 2004). Also, the restoration design incorporated a relatively large number of species, so that the loss of any individual species will not compromise the integrity of the system. Thus, only serious threats will require contingency actions. For this purpose, serious threats are

defined as those which could potentially leave a significant area (i.e., 400 sq. ft.) without vegetation or cause a loss of more than 20% of trees and/or shrubs in a single year.

5.1 Bank and Floodplain Restoration

Maintenance actions to address bank erosion and/or channel bed instability may include one or more of the following as appropriate: (1) repairing the channel bank and/or bed with sand, gravel, or cobbles; and/or (2) the design and installation of a protective structure (e.g., a rock toe protection or log toe protection structures, or a large woody debris deflector with anchor rock) along the unstable reach of the channel bank and/or bed. Actions to address floodplain restoration failures may include: (1) repair or installation of floodplain riffle/weir structures to guide the deposition of sediment onto the floodplain; (2) replacement and/or planting of additional live stakes or live branch layering structures to aid in the deposition of sediment on the floodplain; and/or (3) repair or installation of various types of woody debris on the floodplain (e.g., floodplain brush dike) in assist in natural sedimentation processes. The cause or causes of the initial failure would be taken into consideration in the contingency maintenance action.

5.2 Revegetation Failure

Areas that were part of the restoration design with revegetation, as specified in the mitigation plan for Reach 1 and Monroe Ditch, and determined not to meet the success criteria established in Section 3.4.1 will be replanted using trees and shrubs as outlined on the original planting specifications unless otherwise agreed to by United States et al. Species substitutions may be implemented to favor native species that have established successfully in similar areas of the site. As necessary, herbaceous material will be replanted using at least 2 inch plugs or other appropriate plantings designed to expedite plant establishment and growth. Additional contingency actions may be taken to address the underlying cause of the plant stress and/or failure.

Early signs of widespread animal damage (e.g., cutting, girdling) will be addressed through the installation of tree/shrub guards at the time of original planting. Reports will be evaluated to determine if damage is linked to a species preference and/or basal diameter. Tree/shrub guards will be properly installed around the necessary trees such that growth is not restricted. Guards will be removed once the trees/shrub near growth restriction.

Widespread threats from insects or diseases will be evaluated to determine if the threat is linked to a particular species. As appropriate, preventative and/or curative measures will be taken to prevent and treat further infestation. Natural preventative and/or curative measures will be considered first. If pesticides must be used, caution will be exercised to protect the restored environment.

Locations with widespread plant stress during drought conditions will be addressed through manual irrigation. An irrigation water supply will be delivered to the restoration area by a water truck and sprayed directly on the area by a maintenance crew, if possible. Alternatively, water may be pumped directly from Dicks Creek and applied to the stressed area.

Efforts will be made to remove the significant presence of invasive species of plants that would adversely impact the plantings during the short-term, particularly aggressively invasive, non-native woody species that have previously been observed in and near the restoration areas (e.g., *Lonicera* and *Ailanthus* species) and those described by Ohio Department of Natural Resources (Ohio DNR). During the appropriate season, these species will be cut to the ground, and an appropriate herbicide (e.g., Rodeo™) will be applied to the cut stump, as recommended by Ohio DNR (Appendix B). The application of spot herbicide application was approved by John Estenik of Ohio EPA's Division of Surface Water (Appendix D). Where removal via extraction by hand is considered superior, to avoid overspray and eliminate root mass of invasive species, such removal will be conducted. Invasive herbaceous species such as reed canary grass (*Phalaris arundinacea*) will ultimately be controlled through shading by trees and shrubs, but additional measures may be required in the interim (e.g., cutting and mulching) if overcrowding threatens the growth of planted trees and shrubs. Given the abundance of non-native invasive plant species in the surrounding area, some colonization by non-native species over time is unavoidable.

The natural woven material of erosion control matting and biodegradable stakes are not expected to require maintenance. If flood, animal, or other conditions destroy the erosion control matting before the seeded herbaceous community is established, then measures will be taken replace or repair the erosion control products. If the erosion control matting exhibits ineffectiveness before the seeded herbaceous community is established, then an alternative erosion control product will be used.

5.3 Failure to Meet QHEI, ICI, or IBI Performance Criteria

If the restored segments of Reach 1 of Dicks Creek and/or Monroe Ditch do not meet QHEI, ICI, and/or IBI performance criteria, the post-restoration monitoring period may have to be extended and/or contingency maintenance actions may have to be conducted. The type of contingency maintenance action undertaken will depend on the type of performance failure but may include actions to further stabilize channel banks and floodplain areas identified as unstable or eroding; and/or repairing, replacing, or constructing new engineered or constructed stream control measures. The appropriate contingency maintenance action will be determined in consultation with United States et al.

6.0 HEALTH AND SAFETY

The *Interim Measures Health and Safety Plan* (HASP [ENVIRON, 2006a]) addresses the potential chemical and physical hazards present in the Interim Measures restoration area and includes provisions for health and safety monitoring and emergency procedures. All field activities will require that all site workers and contractors conform to AK Steel safety requirements, with respect to training, drug testing, and personal protective equipment. All authorized site personnel will be required to sign a HASP acknowledgment form, indicating that they will abide by all the procedures and protocols set forth in the *Interim Measures HASP* (ENVIRON, 2006a) or most current HASP at the time of the field event.

AK Steel's selected contractor(s) for performance of the tasks related to this O&M Plan may be required to develop their own HASP which, at minimum, will meet the requirements specified in the *Interim Measures HASP* or most recent version thereof. The contractor(s)' HASP will be maintained at an on-site location and in the project file. In the event that multiple HASPs are in effect during project work and the requirements are in conflict, the more conservative HASP requirement will prevail.

7.0 QUALITY ASSURANCE

The *Interim Measures Quality Assurance Project Plan* (QAPP [ENVIRON, 2006b]) addresses the procedures necessary to document field measurements and includes a description of quality assurance objectives and data reduction and reporting requirements. Data records, log sheets, and other documentation will be reviewed for accuracy and completeness, assuring its adherence to high scientific and technical standards in accordance with the Interim Measures Quality Assurance Project Plan or most recent version thereof.

8.0 DATA MANAGEMENT AND REPORTING

The *Interim Measures Data Management Plan* (DMP [ENVIRON, 2006c]) addresses the procedures necessary to document and track data and results associated with this O&M plan (including field data and geospatial data). The *Interim Measures DMP* describes the project, project organization and responsibility, and data flow, transformation, reduction, transfer, reporting, tracking, and security. The Interim Measures DMP, or the most current version of the DMP in effect at the time of data generation, will be implemented for the work conducted in accordance with this O&M Plan.

8.1 Annual Mitigation Monitoring Report

Mitigation monitoring reports will be submitted to Ohio EPA annually for Years 1 through 5. The Year 1 report will be submitted to Ohio EPA by December 31 of the first full year after the end of the first full growing season following completion of restoration of Reach 1. All subsequent reports will be submitted by December 31 of each remaining monitoring year.

Unless otherwise agreed with USEPA et al. in the interim, the reports will be prepared in accordance with the document entitled *Integrated Wetland Assessment Program. Part 6: Standardized Monitoring Protocols and Performance Standards for Wetland Creation, Enhancement and Restoration, Version 1.0,* prepared by Ohio EPA. These reports will (1) summarize the results of the inspections, evaluations, surveys and other monitoring actions (e.g., photographs) undertaken as part of this O&M plan and (2) compare the current results to results of the previous year to evaluate if the goals of the restoration are being met. In addition, the mitigation monitoring report prepared for Year 1 will include a full copy of the 2010 and 2012 final U.S. Army Corps of Engineers permits for the Year 1 Dicks Creek and Monroe Ditch, and the Year 2 Dicks Creek, remediation and mitigation projects.

9.0 PUBLIC INVOLVEMENT

The *Interim Measures Public Involvement Plan* (PIP [ENVIRON, 2006d]) and subsequent updates address the tools necessary to keep the public informed regarding activities associated with investigation, remediation, and restoration of the Dicks Creek Study Area. Consistent with the *Interim Measures PIP* or the most current PIP in effect at the time of the O&M work, the following measures will be taken.

9.1 Information Repository

An Information Repository will be established at the MidPointe Middletown Public Library to ensure that site-related information is available to the public. This O&M plan and other documents described in this plan (e.g., DMP, PIP, QAPP) are available for public access in the information repository. Subsequent reports will be available within 30 days of submittal of the final document after United States et al. approval.

The address, phone number, and hours of operation for the repository are provided below.

MidPointe Middletown Public Library
125 S. Broad Street
Middletown, OH 45044
513-424-1251

Hours of Operation:
Monday through Thursday 9:00 a.m. – 9:00 p.m.
Friday 9:00 a.m. – 7:00 p.m.
Saturday 9:00 a.m. – 5:00 p.m.
Sunday 1:00 p.m. – 5:00 p.m.

The repository is handicapped accessible and contains photocopying capabilities.

9.2 Toll-free Environmental Information Line

A telephone hotline was established in June 2006 to allow for the public to contact the Public Relations Coordinator with questions, concerns and comments about the Interim Measures remediation, as well as all other activities conducted under the 2006 Consent Decree (e.g., current and upcoming activities, Information Repository). This toll-free information line allows the public to contact the Public Relations Coordinator with questions, concerns, and comments about any work AK Steel and its contractors are performing under the Consent Decree. The number is:

1-866-902-4AKS or 1-866-902-4257

The hotline will be answered during normal business hours, 8:30 a.m. to 4:30 p.m., Monday through Friday, and messages can be left after normal business hours.

10.0 SCHEDULE

This O&M plan will begin being fully implemented following the completion of the restoration of Reach 1 Dicks Creek and Monroe Ditch, detailed in the documents entitled *MDA-33S, Monroe Ditch, and Dicks Creek Reach 1 Sediment and Floodplain Soil Remediation Design Document* and the *Dicks Creek Year 2 Sediment and Floodplain Soil Remediation Design Document*. The procedures described in this O&M plan will begin after the completion of the restoration of Reach 1 of Dicks Creek and Monroe Ditch (e.g., after the end of the first full growing season following completion of restoration). Based on the completion of Reach 1 restoration in calendar year 2012, the O&M monitoring presented in this plan will be implemented beginning in calendar year 2014. The inspections, surveys, evaluations, and monitoring will be conducted until Year 5 (i.e., 5 years after completion of the restoration). The O&M plan includes conducting:

- Walk-through inspections quarterly in Years 1 through 3, and semi-annually in Years 4 and 5;
- Channel and floodplain evaluations initially after completion of the restoration (Year 1 [as built]) and in Years 3 and 5;
- Surface water sampling in Years 1 through 5;
- Sediment sampling in Years 1, 3;and 5;
- Hydrology monitoring in Years 1 through 5;
- Revegetation surveys in Years 1, 3;and 5;
- Stream habitat surveys in Years 1, 3, and 5; and
- An aquatic biological assessment in Years 1, 3, and 5.

The results of the Reach 1 and Monroe Ditch inspections, surveys, evaluations, and monitoring conducted as part of this O&M plan will be provided in annual mitigation monitoring reports. These reports will also document any significant maintenance activities conducted in response to those results.

11.0 REFERENCES

ARCADIS G&M. 2004. Net Environmental Benefits Analysis for Reach 2 Remedial Alternatives, Dicks Creek, Middletown, Ohio. October.

ENVIRON. 2006a. Interim Measures Health & Safety Plan, Dicks Creek Study Area, Middletown, Ohio. June.

ENVIRON. 2006b. Interim Measures Quality Assurance Project Plan, Dicks Creek Study Area, Middletown, Ohio. June

ENVIRON. 2006c. Interim Measures Data Management Plan, Dicks Creek Study Area, Middletown, Ohio. June.

ENVIRON. 2009. Restoration of Reach 1 of Dicks Creek, Monroe Ditch, and Outfall 002 Operation and Maintenance Plan, AK Steel Corporation, Middletown, Ohio. March.

Ohio EPA. 1988a. Biological Criteria for the Protection of Aquatic Life, Volume I: The Role of Biological Data in Water Quality Assessment (02/15/88). Ohio Environmental Protection Agency, Columbus, Ohio.

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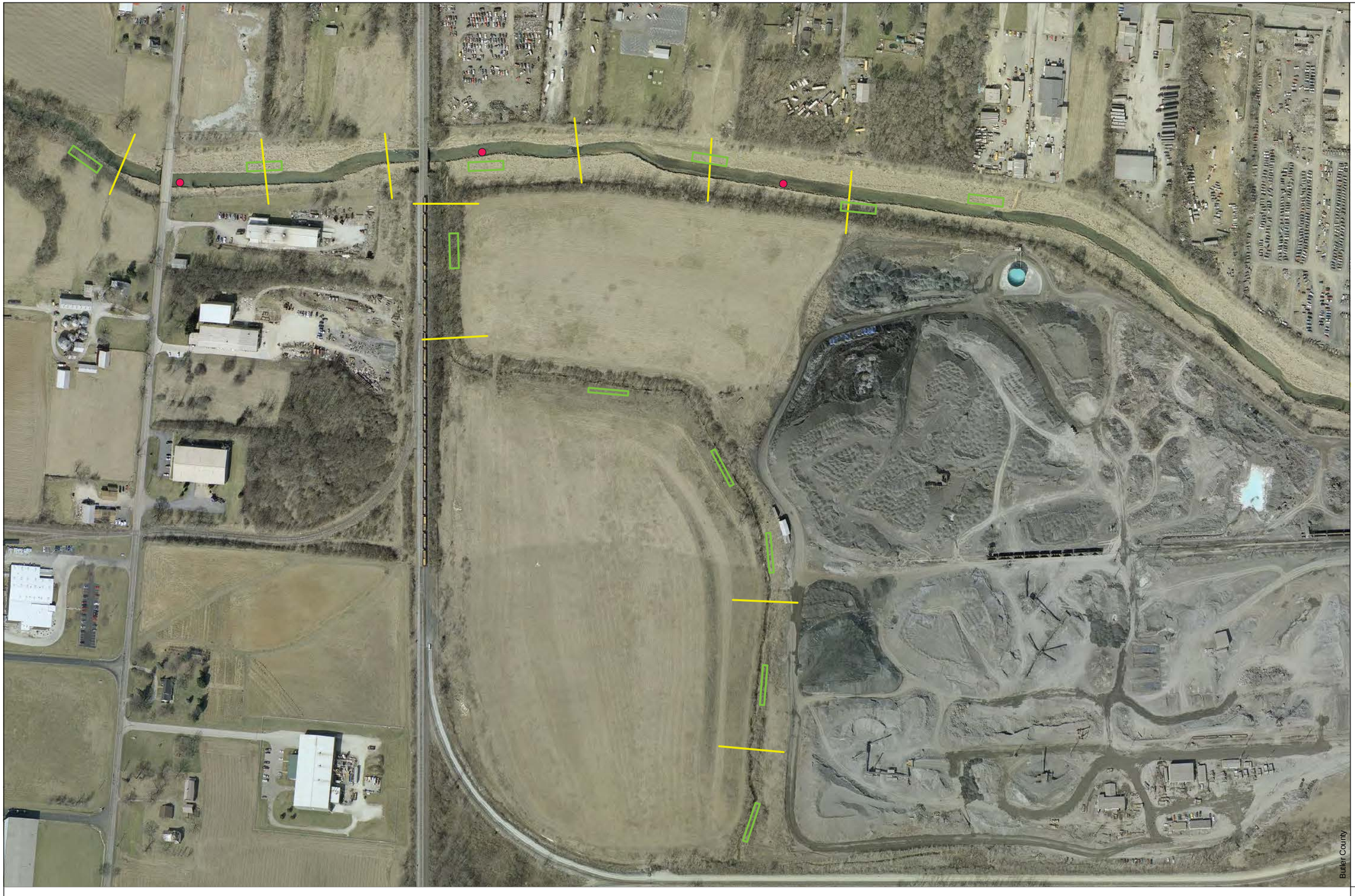
Ohio EPA. 1997. Biological and Water Quality Study of the Middle and Lower Great Miami River and Selected Tributaries, 1995. Montgomery, Warren, Butler, and Hamilton Counties (Ohio). Technical Report MAS/1996-12-8.

Ohio EPA. 2004. Integrated Wetland Assessment Program. Part 6: Standardized Monitoring Protocols and Performance Standards for Wetland Creation, Enhancement and Restoration, Version 1.0, Ohio EPA Technical Report WET/2004-6.

Figures



LEGEND

FQAI Areas

QHEI Locations 1987-2000

Proposed QHEI Zones

N

0 560

Feet

Floristic Quality Assessment Index (FQAI) Areas and
Qualitative Habitat Evaluation Index (QHEI) Areas, Middletown, Ohio

Biohabitats
GREAT LAKES BIOREGION
2026 Murray Hill Road / Rm. 102 / Cleveland, OH / 44106

Appendix A

Log Sheets

KEMRON ENVIRONMENTAL SERVICES

Page _____ of _____

Revegetation Surveys-Dicks Creek

Date _____

Project Restoration of Reach 1 of Dicks Creek and Monroe Ditch **Location** Middletown, Ohio

Inspection Team _____

NOTE: *Include description and approximate location data relative to phytoremediation baseline markers (e.g., 6+50) and zone (e.g., primary bank, saturated zone, lower terrace, upper bank). Provide photodocumentation, as appropriate.*

Inspection Area *(nearest station)*	**General Vegetation Failures** *(provide apparent or likely cause and area estimate)*	**General Erosion or Unstable Banks** *(provide apparent or likely cause and area estimate)*
166+00		
161+00		
156+00		
148+00		
140+00		
134+00		

NOTE: *Visually estimate total tree canopy cover and ground cover for each individual shrub species and the entire herbaceous community.*

Survey Plot	**Tree Cover Score**	**Ground Cover Score**					
1		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
2		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
3		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
4		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
5		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
6		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					

Additional Comments _____

Cover Score

0 = no cover
1 = >0 to 20%
2 = >20 to 40%
3 = >40 to 60%
4 = >60 to 80%
5 = >80 to 100%

KEMRON ENVIRONMENTAL SERVICES

Page _____ of _____

Revegetation Surveys-Monroe Ditch

Date _____

Project Restoration of Reach 1 of Dicks Creek and Monroe Ditch **Location** Middletown, Ohio

Inspection Team _____

NOTE: *Include description and approximate location data relative to phytoremediation baseline markers (e.g., 6+50) and zone (e.g., primary bank, saturated zone, lower terrace, upper bank). Provide photodocumentation, as appropriate.*

Inspection Area *(nearest station)*	**General Vegetation Failures** *(provide apparent or likely cause and area estimate)*	**General Erosion or Unstable Banks** *(provide apparent or likely cause and area estimate)*
31+00		
26+00		
22+00		
18+00		
13+00		
3+00		

NOTE: *Visually estimate total tree canopy cover and ground cover for each individual shrub species and the entire herbaceous community.*

Survey Plot	**Tree Cover Score**	**Ground Cover Score**					
1		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
2		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
3		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
4		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
5		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					
6		sp.1			sp.5		
		sp.2			sp.6		
		sp.3			herbaceous community		
		sp.4					

Additional Comments _____

Cover Score

0 = no cover
1 = >0 to 20%
2 = >20 to 40%
3 = >40 to 60%
4 = >60 to 80%
5 = >80 to 100%

KEMRON ENVIRONMENTAL SERVICES

Page _____ of _____

REVEGETATION SURVEY PLOT LOG SHEET

Survey Plot No. _____ **Date** _____

Project Restoration of Reach 1 of Dicks Creek and Monroe Ditch **Location** Middletown, Ohio

Inspection Team _____

NOTE: *Visually estimate total tree canopy cover and ground cover for each individual shrub species and the entire herbaceous community.*

Tree Cover Score	Ground Cover Score					
	sp.1			sp.5		
	sp.2			sp.6		
	sp.3			herbaceous community		
	sp.4					

Cover Score

0 = no cover **3 = >40 to 60%**
1 = >0 to 20% **4 = >60 to 80%**
2 = >20 to 40% **5 = >80 to 100%**

Additional Comments _____

NOTE: *Count each tree and shrub species inside of revegetation survey plot.*

Species	Count	Species	Count
Tree 1		Shrub 1	
Tree 2		Shrub 2	
Tree 3		Shrub 3	
Tree 4		Shrub 4	
Tree 5		Shrub 5	
Tree 6		Shrub 6	
Tree 7		Shrub 7	
Tree 8		Shrub 8	
Tree 9		Shrub 9	
Tree 10		Shrub 10	
Tree 11		Shrub 11	
Tree 12		Shrub 12	
Tree 13		Shrub 13	
Tree 14		Shrub 14	
Tree 15		Shrub 15	
Tree 16		Shrub 16	
Tree 17		Shrub 17	
Tree 18		Shrub 18	
Tree 19		Shrub 19	
Tree 20		Shrub 20	
Tree 21		Shrub 21	
Tree 22		Shrub 22	
Tree 23		Shrub 23	
Tree 24		Shrub 24	
Tree 25		Shrub 25	
Total Tree Stems		**Total Shrub Stems**	

Dicks Creek/Monroe Ditch Monthly Inspection Form

Date: _____

Inspector: _____

Areas of Inspection					
Dicks Creek	Yes	No	Observation	Corrective Action	Date Completed
Evidence of meso-scale channel incision or aggradation?					
Evidence of failed engineering or constructed stream?					
Evidence of natural stream processes?					
Presence of eroded or unstable banks?					
Presence of general vegetation failure?					
Presence of crowding/choking?					
Monroe Ditch	Yes	No	Observation	Corrective Action	Date Completed
Evidence of meso-scale channel incision or aggradation?					
Evidence of failed engineering or constructed stream?					
Evidence of natural stream processes?					
Presence of eroded or unstable banks?					
Presence of general vegetation failure?					
Presence of crowding/choking?					
Other Notable Observations					

Appendix B

Invasive Species

INVASIVE PLANTS OF OHIO

Fact Sheet 1

Amur, Morrow & Tatarian Honeysuckle

Lonicera maackii, L. morrowii, L. tatarica

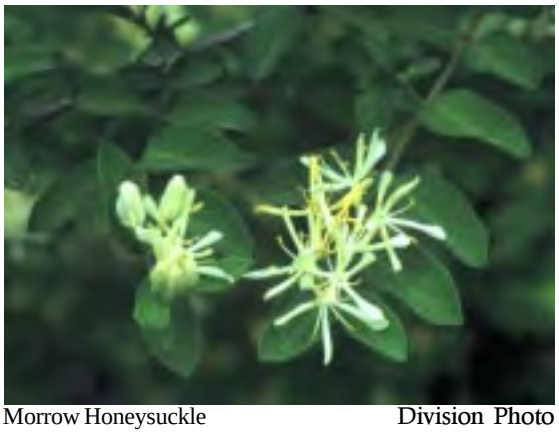
Amur Honeysuckle Division Photo

DESCRIPTION:

Amur, Morrow and Tatarian honeysuckles are non-native, upright, deciduous shrubs that grow to be 6-15 feet tall. The best way to distinguish these three species are by their leaves and flowers/fruits. Amur honeysuckle has dark green leaves that end in a sharp point at the tip and the underside of the leaf has hair along the veins. Morrow and Tatarian both have oval, egg-shaped leaves. By contrast, the leaf of Tatarian honeysuckle lacks hair on the underside, while Morrow is consistently hairy on the underside. Amur and Morrow both have white, paired flowers that turn yellow with age while Tatarian is pale pink. The flower peduncles (stems) are also descriptive: Amur has very short, pubescent peduncles (2-4mm), Morrow's are long and pubescent (10-12mm), and Tatarian's are long and glabrous (10-15mm) and all three exhibit a hollow stem in cross-section which can be used to distinguish them from some native honeysuckles. The fruits are yellow to dark-red berries. Showy pink honeysuckle (*L.* x*bella*) is an invasive hybrid of Morrow and Tatarian honeysuckle with showy pink flowers. Shrub bush-honeysuckle (*Diervilla lonicera*) is native to Ohio and can be distinguished from these non-native species by the solid pith of the stem and yellow to reddish flowers.

HABITAT:

These bush honeysuckles are adaptable to a wide range of habitats. They are most commonly found in the understory of woodlands as well as the edges of marshes.



Morrow Honeysuckle Division Photo

Tatarian Honeysuckle Division Photo

DISTRIBUTION:

Amur, Morrow and Tatarian honeysuckles are native to China, Korea and Japan. Introduced into the United States in 1846 as ornamental plants, they have escaped cultivation due to high seed production and to the fact their seeds are readily eaten and dispersed by birds. These honeysuckles are distributed throughout Ohio with Amur being more problematic in southwestern Ohio, Morrow in northern Ohio, and Tatarian throughout the state.

PROBLEM:

These vigorous shrubs shade out native vegetation, particularly in the woodland understory. They are able to out-compete native wildflowers for light and other resources. Bush honeysuckles green up earlier in the spring than most other plants, giving them an advantage over other species. Each produces abundant amounts of seed which are spread by birds and other animals.

Amur Honeysuckle Division Photo

CONTROL:

Mechanical: The bush honeysuckles in less dense populations can be pulled, making sure that all the roots have been removed. Any remaining roots in the ground are likely to re-sprout. A pulaski, Weed Wrench, or other similar tool may be used to remove the plant from the ground.

Chemical: For more dense populations, systemic herbicides, such as Roundup®, Glypro®, Garlon 3A®, and Garlon 4®, are the most effective control. The best methods of application are foliar spray for large populations when there are no desirable species in the vicinity, cut stump treatment for areas with desirable non-target species, and basal bark applications which are effective throughout the year whenever the ground is not frozen. Foliar application should only be used when the outside temperature is above 65° F to allow for complete absorption of the chemical. It may also be applied to re-sprouts after cutting. Cut stump treatment with Garlon 4® can be applied year-round as long as the ground is not frozen.

Biological: There are currently no biological control methods for these honeysuckles.

ADDITIONAL INFORMATION SOURCES:

Bartlow, J., K. Johnson, M. Kertis, T. Remaley, S. Ross, E. Simet, T. Smith, D. Soehn and G.Taylor. 1996. Tennessee Exotic Plant Management Manual. Tennessee Exotic Pest Plant Council.

Converse, Carmen K. 1984. Element Stewardship Abstract for *Lonicera* spp., Bushy Honeysuckles. The Nature Conservancy.

March 2001

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Funding Provided by an Ohio EPA Environmental Education Grant

FS1CM

INVASIVE PLANTS OF OHIO

Fact Sheet 2

Glossy Buckthorn & Common Buckthorn

Rhamnus frangula, R. cathartica

DESCRIPTION:

Glossy Buckthorn John Watts

Both glossy buckthorn and common buckthorn are non-native woody shrubs or small trees that can reach up to 20 feet in height. Cutting the stems of either species reveals a distinctive yellow sapwood and pink to orange heartwood. Glossy buckthorn has gray-brown bark and lightly colored lenticels which give the bark a speckled appearance. Leaves of glossy buckthorn are entire, 1-3 inches long, shiny on the upper surface, oval shaped and slightly wavy. Flowers are 5-petaled, greenish-white and the fruits are red, turning purplish-black when ripe. Plants flower from late May until the first frost and fruits ripen from early July to September. Common buckthorn has smooth, deeply veined, oval leaves (1-2½ inches long) with toothed margins. Common buckthorn is a dioecious species with male and female flowers on separate plants. Flowers are 4-petaled and yellow-green in color; fruits are black. Flowering takes place from May through June and fruits ripen from August to September. Twigs of common buckthorn are often tipped with short spines. A native species, Carolina buckthorn (*Rhamnus caroliniana*), also occurs in Ohio.

HABITAT:

Glossy buckthorn typically invades wetlands including swamps, bogs, fens and wet meadows but also occurs in upland habitats such as woodland edges, old fields and roadsides. Common buckthorn is primarily an invader of upland sites including open woods, woodland edges, prairies and open fields. Both species are capable of growing in full sun as well as heavily shaded areas.

Common Buckthorn Division Photo

DISTRIBUTION:

Glossy buckthorn and common buckthorn were introduced to North America from Eurasia as ornamental shrubs for fence rows and wildlife habitat and are still used in landscaping. These species are distributed throughout the northeast and north central U.S. Both species are frequent in the central and northern part of the state.

PROBLEM:

Both glossy and common buckthorn have a wide habitat tolerance, rapid growth rates and extensive root systems. Both species produce abundant flowers and fruits throughout the growing season. Seeds are widely dispersed by birds. Once established, these species aggressively invade natural areas and form dense thickets displacing native species. They leaf out very early in the growing season and keep their leaves late into the fall helping to shade out native trees, shrubs and wildflowers.

CONTROL:

Mechanical: Prescribed burning has been used to control buckthorns in some natural areas. Fire will top kill stems, however re-sprouting will occur and seed germination may increase. Several years of burning may be necessary to control these species and may not be appropriate in some natural areas. Hand pulling may be successful in small infestations, although several seasons may be required as re-sprouting will occur if part of the root is left behind. This method also disturbs the soil, increasing seed germination. Repeated mowing has been reported effective in maintaining open areas and preventing seedling establishment.

Chemical: Control of buckthorns with systemic herbicides has been successful in many situations. Application of Roundup®, Accord®, Glypro® or Garlon 4® to cut stumps during the growing season and in warm days of winter has proven to be effective. Other application methods may include basal bark and foliar application. A foliar application of Garlon 3A® in dense thickets may be very effective in the spring and fall. Without treatment, stems will re-sprout vigorously after cutting due to the extensive root system.

Biological: Biological controls are not available, however studies of possible fungal and insect pests are ongoing.

ADDITIONAL INFORMATION SOURCES:

Converse, C.K. 1999. Element Stewardship Abstract for *Rhamnus cathartica, Rhamnus frangula*. The Nature Conservancy.

Reinartz, J.A. 1997. Controlling glossy buckthorn (*Rhamnus frangula* L.) with winter herbicide treatments of cut stumps. Natural Areas Journal 17(1): 38-41.

March 2001

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Funding Provided by an Ohio EPA Environmental Education Grant

FS2KC

INVASIVE PLANTS OF OHIO

Fact Sheet 3

Garlic Mustard

Alliaria petiolata

DESCRIPTION:

John Watts

Garlic mustard is a non-native, biennial herb that grows 5-46 inches tall. The first-year plant is in the form of a rosette with kidney-shaped leaves that remain green throughout the winter. The second year, a flowering stem is produced with triangular-shaped leaves that are sharply toothed. Crushed leaves emit a garlic-like odor. The flowers bloom in a cluster at the end of the stem. Each small flower has four white petals and blooms from May to June. The fruits are long, green capsules that become brown as the seeds mature, making it easy to identify.

HABITAT:

Garlic mustard generally prefers some shade and can be found in upland and flood plain forests, savannas, yards, along roadsides, and occasionally in full sun. This plant invades forests first at the edge, then progresses to the interior along streams and trails.

Division Photo

DISTRIBUTION:

Garlic mustard originated in Europe and was introduced to the United States for herbal and medicinal puroses. It was first recorded in the United States in 1868 in Long Island, New York. By 1991, garlic mustard had invaded 28 Midwestern and northeastern states. Garlic mustard can be found throughout the state of Ohio.

PROBLEM:

Garlic mustard aggressively out-competes native species in the understory of forests and woodlands. This plant begins growth in early spring and ends growth later in the season than most native species. As a result, garlic mustard shades out native wildflowers and out-competes native seedlings. Garlic mustard grows in dense clusters and can displace most herbaceous native plants within 10 years. Large quantities of seed are produced and can remain viable in the soil for up to 7 years. The seeds are dispersed by wind, water and transported by animals and humans.

CONTROL:

Mechanical: Mechanical controls of garlic mustard include hand-pulling and cutting, and are most effective on smaller infestations. Hand-pulling of plants can be very effective, although labor intensive. Care must be taken to insure that the entire plant is removed and that all plant materials are bagged and moved off-site. A plant can continue to mature and produce seeds even if it has been pulled up. Hand-pulling and removal must continue until the seed bank is exhausted (at least 7 years). Cutting populations of garlic mustard is effective for medium to large concentrations of plants. Stems may be cut by mowing, brush-cutting, or by hand when the plants are in flower. This can result in total mortality of the plants, however it does not affect the seed bank. Cutting must continue every year until the seed bank is exhausted. Prescribed fire can be an effective control agent in controlling garlic mustard given the proper location and fire intensity. Repeated, effective burns over several years are necessary.

Chemical: Foliar application of herbicide can be used to control populations of garlic mustard where mechanical methods may not be effective, such as large infestations. Roundup® or Glypro® are effective herbicides to use, however they are not selective so non-target species in the vicinity of the application may be affected. Herbicide should be applied to the first year rosettes during the late fall and early spring when non-target species are dormant.

Biological: Currently there are no programs in use, however research is being conducted to find a potential biological control agent.

ADDITIONAL INFORMATION SOURCES:

Bartlow, J., K. Johnson, M. Kertis, T. Remaley, S. Ross, E. Simet, T. Smith, D. Soehn and G.Taylor. 1996. Tennessee Exotic Plant Management Manual. Tennessee Exotic Pest Plant Council.

Nuzzo, V. 1994. Element Stewardship Abstract for *Alliaria petiolata*, Garlic Mustard. The Nature Conservancy.

Wisconsin Bureau of Endangered Resources. 1992. Invasive Species Control Manual. Garlic Mustard, *Alliaria petiolata*.

March 2001

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FS3CM

INVASIVE PLANTS OF OHIO

Fact Sheet 4

Purple Loosestrife

Lythrum salicaria

DESCRIPTION:

Division Photo

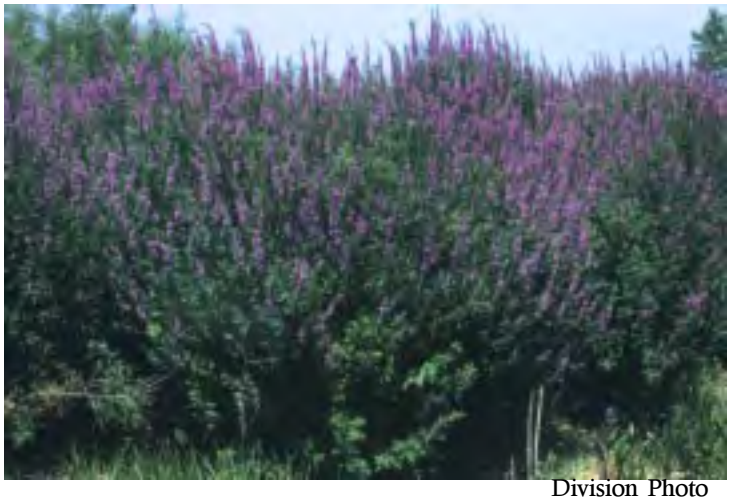
Purple loosestrife is a dense, herbaceous, non-native perennial that grows up to 7 feet tall. With attractive purple to magenta flowers, purple loosestrife cultivars are a popular ornamental. The flowers bloom in long spikes with 1-50 square stems per plant. One plant can produce over 100,000 seeds. The linear green leaves are opposite along the stem. This plant has a woody taproot and fibrous rhizomes that form a thick mat. Purple loosestrife is similar to the native loosestrife *Lythrum alatum*, however, *L. alatum* has alternate leaves on the upper stem, wider spaced flowers and is smaller in size. Looking closely at both flowers *L. salicaria* has 12 stamens and *L. alatum* has 4-6 stamens. Currently in Ohio, *Lythrum salicaria* is illegal to sell. However, commercially available cultivars like *L. virgatum* can cross pollinate with wild populations of purple loosestrife and produce viable seed.

HABITAT:

Purple loosestrife occurs mostly in wetland environments, but when well established, it can survive drier conditions. Wetlands impacted by this plant include marshes, fens, wet meadows, stream and river banks, and lake shores.

DISTRIBUTION:

Purple loosestrife was introduced to North America from Europe and Asia in the early 1800s as a contaminant in ship ballast, as well as a medicinal herb and garden plant. It escaped and became a pioneer species of newly constructed waterways and canals. Purple loosestrife occurs throughout the United States with its heaviest concentrations in the northeast. Although *Lythrum salicaria* is currently no longer available to purchase, cultivars continue to be distributed. In Ohio, this plant can be found throughout the state, although it is more established in the northern half.



Division Photo

PROBLEM:

Purple loosestrife adapts readily to natural and disturbed wetlands. As it establishes and expands, it out-competes and replaces native grasses, sedges, and other flowering plants that provide a higher quality source of nutrition for wildlife. Purple loosestrife forms dense, homogeneous stands that restrict native wetland plant species and reduces habitat for waterfowl. Seed production is as prolific as the vegetative growth. Seeds are widely distributed by animals, machinery and people and in waterways.

CONTROL:

Mechanical: Small infestations of purple loosestrife can be removed by hand. The entire root system must be removed from the ground. All plant material should be bagged and removed from the area to eliminate re-sprouting. Larger populations are harder to control using mechanical means. Mowing should not be used because it can increase the spread of the population by dispersing seeds and exposing the seed bank.

Chemical: Herbicides can be used effectively to control small populations of purple loosestrife. Only herbicides permitted for wetland use, such as Accord® or Glypro®, may be used. By eliminating all the plants in an area, the soil is exposed for the immense purple loosestrife seed bank to germinate. Spot application of herbicide can help limit this problem. The most species specific way to apply herbicide is by cutting and treating the stems. Foliar spray can be used by applying herbicide after the period of peak bloom, in late August. Any control method should be followed up on a yearly basis to catch any missed plants or new sprouts. Certain broadleaf specific herbicides, such as Garlon 3A®, which do not harm monocot species (grasses and sedges) that typically occur in wetlands, can also be used.

Biological: Several species of insects are being studied for their effectiveness in the control of purple loosestrife. A species of weevil (*Hylobius transversovittatus*) lays eggs in the stem and upper root system of the plant and as the larvae develop, they feed on root tissue. Two species of leaf-eating beetles (*Galerucella calmeriensis* and *G. pusilla*) and a weevil (*Nanophyes marmoratus*) that feeds on flowers and stresses the plant are being released into areas of high purple loosestrife density and are being monitored. Since 1994, the Ohio Division of Wildlife has introduced these insects into 13 areas. Although this method will not eradicate the species, it may create a more tolerable population level that will stabilize over time.

ADDITIONAL INFORMATION SOURCES:

Bartlow, J., K. Johnson, M. Kertis, T. Remaley, S. Ross, E. Simet, T. Smith, D. Soehn and G.Taylor. 1996. Tennessee Exotic Plant Management Manual. Tennessee Exotic Pest Plant Council.

Bender, J. and J. Rendall. 1988. Element Stewardship Abstract for *Lythrum salicaria*, Purple loosestrife. The Nature Conservancy.

Hoffman, R. and K. Kearns, eds. 1997. Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants. Bureau of Endangered Resources, Wisconsin Department of Natural Resources.

March 2001

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Funding Provided by an Ohio EPA Environmental Education Grant

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INVASIVE PLANTS OF OHIO

Fact Sheet 5

Common Reed Grass

Phragmites australis

Division Photo

DESCRIPTION:

Common reed grass is a tall, invasive perennial wetland grass ranging in height from 3-15 feet. The plant produces horizontal rhizomes that grow on or beneath the ground and produce roots and vertical stalks (culms). The rhizomes allow the plant to form large colonies. The stiff, hollow stalks support leaf blades which are smooth, broad and flat (1½ - 2 inches wide). A large terminal inflorescence (panicle) is produced in late June and is purplish in flower and grayish in fruit. Large quantities of seed are produced, however, most or all of the seed may not be viable.

HABITAT:

Common reed grass is prevalent in open wetland habitats and favors alkaline and brackish waters. These areas include drier borders and elevated areas of brackish and freshwater marshes, along riverbanks and lake shores and almost anywhere there are slight depressions that hold moisture. The species is particularly frequent in disturbed or polluted soils along roadsides, ditches and dredged areas. It is also known to tolerate highly acidic conditions.

DISTRIBUTION:

Some populations of common reed grass are more invasive than others and may be non-native. It is suspected that the non-native, aggressive strain of common reed grass was introduced to North America in the early 20th century. It can now be found throughout the United States. In Ohio, this strain is primarily found in the northern part of the state, however it has recently progressed south.

PROBLEM:

Common reed grass can be considered a natural component of some undisturbed wetlands. However, the invasive strain grows aggressively in areas that are disturbed or stressed by pollution, dredging or other alteration of the natural hydrologic regime. Invasive stands of common reed grass eliminate diverse wetland plant communities, providing little food or shelter for wildlife.

Division Photo

CONTROL:

Mechanical: Cutting, pulling or mowing can be done in late July and should be repeated for several years. All cut shoots should be carefully removed to prevent re-sprouting. The placement of black plastic over cut stems has had some success and burning in combination with herbicide application has also been effective in some situations. Hydrologic controls such as flooding for an extended period during the growing season may also be successful.

Chemical: Herbicide application with Accord®, Rodeo® or Glypro® is most effective in the early fall, after tasseling, and should be applied at least two years in a row. Fusilade DX®, a grass specific herbicide can be applied in non-aquatic areas. Methods of application will depend on the associated plant community but may include aerial spraying, hand-held or backpack sprayers and hand-wicking.

Biological: No biological controls are known at this time.

ADDITIONAL INFORMATION SOURCES:

Marks, M., B. Lapin and J. Randall. 1994. *Phragmites australis* (*P. communis*): Threats, Management and Monitoring. Natural Areas Journal 14(4): 285-294.

Randall, J. 1993. Element Stewardship Abstract for *Phragmites australis*. The Nature Conservancy.

March 2001

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Funding Provided by an Ohio EPA Environmental Education Grant

FS5KC

INVASIVE PLANTS OF OHIO

Fact Sheet 6

Reed Canary Grass

Phalaris arundinacea

DESCRIPTION:

Reed canary grass is a 2-9 foot tall, non-native grass with flat, rough-textured, tapering leaves from 3½-10 inches long. The stem is hairless and stands erect. One of the first grasses to sprout in the spring, reed canary grass produces a compact panicle 3-16 inches long that is erect or slightly spreading. The flowers are green to purple early in the season and change to beige over time. This grass forms a thick rhizome system that quickly dominates the soil. There is some debate as to the origin of the species. Sources document native and non-native genotypes of reed canary grass. The non-native strain is thought to be more invasive than the native strain.

HABITAT:

Reed canary grass occurs in wetlands such as marshes, wet prairies, wet meadows, fens and stream banks. This grass quickly dominates areas of wet, exposed soils and can also grow in areas of standing water by producing special roots off the submersed portion of the stem. Reed canary grass can also grow on dry soils in upland sites and under partial shade; however, it does best in full sun and moist soils.

DISTRIBUTION:

The non-native strain of reed canary grass was introduced from Europe and Asia in the early 1800s. It was selected for its vigor as a forage crop and erosion control. In Ohio, reed canary grass is widespread throughout the state.

PROBLEM:

Reed canary grass reproduces vegetatively as well as by seed. It aggressively dominates an area and displaces the native vegetation replacing it with a monoculture of grass. This species of grass produces little in the form of shelter and food for wildlife, although it has been used for bank stabilization in wetlands and waterways. Seeds are easily dispersed by means of waterways, animals and people.

Division Photo

Division Photo

CONTROL:

Mechanical: In smaller patches, hand-pulling or digging may be effective. Mowing can be used to control seed production by mowing in early to mid-June and early October before seed matures. This also exposes the soil to light which will promote the growth of other species. Discing or plowing can also be used to control a well-established population. Although prescribed burning can be effective, it must be repeated annually for 5 or 6 years. Timing may be difficult due to fluctuating water levels and the growth stage of the plants at burn time. A combination of these measures used together may improve results.

Chemical: Herbicides, such as Accord® or Glypro®, can be applied to control reed canary grass. Fusilade DX®, a grass specific herbicide, can be applied in non-wetland areas. Herbicide should be applied in early spring when non-target species are still dormant. Removal of the previous year's growth to expose the new green shoots aids effectiveness of the chemical and minimizes the amount needed. Foliar application of Glypro® to larger monocultures of reed canary grass can be effective. Chemical treatments following mowing in the fall season can help control this grass as well.

Biological: There are currently no biological control methods in use for reed canary grass.

ADDITIONAL INFORMATION SOURCES:

Hoffman, R. and K. Kearns, eds. 1997. Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants. Bureau of Endangered Resources, Wisconsin Department of Natural Resources.

Hutchison, M. 1990. Vegetation Management Guideline: Reed canary grass (*Phalaris arundinacea*). Illinois Nature Preserves Commission.

Lyons, K.E. 2000. Element Stewardship Abstract for *Phalaris arundinacea*. The Nature Conservancy.

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FS6CM

INVASIVE PLANTS OF OHIO

Fact Sheet 7

Autumn-Olive and Russian-Olive

Elaeagnus umbellata, E. angustifolia

DESCRIPTION:

Autumn-olive and Russian-olive are non-native, deciduous shrubs or small trees that grow to 20 feet tall. The leaves on autumn-olive are small, oval, untoothed and dark green. It has small, light-yellow fragrant flowers in May-June and small round juicy fruits that are reddish to pink in color and dotted with silver or brown scales. Russian-olive's leaves are narrower and longer, and dull green. It has yellow flowers and dry yellow mealy fruits. Silver scales occur on the underside of the leaves of both species. The twigs of Russian-olive are typically covered with thorns. These shrubs begin to flower and fruit annually after 3 years. An individual plant can produce 8 pounds of fruit each year.

HABITAT:

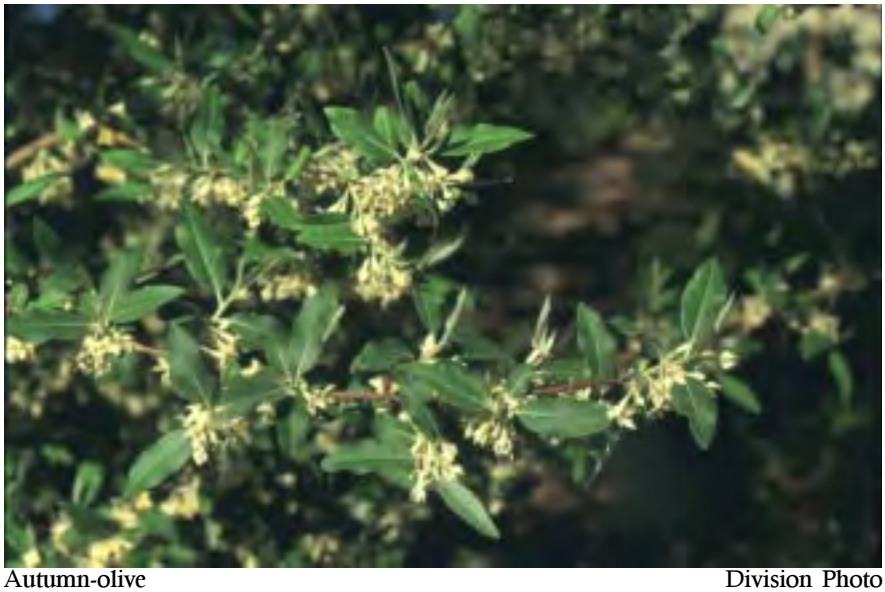
Autumn-olive and Russian-olive have nitrogen-fixing root nodules which allows them to adapt to many poor soil types. They are found in areas such as pastures and fields, grasslands and sparse woodlands.

DISTRIBUTION:

Autumn-olive is native to China and Japan. It was introduced to the United States in 1830 and is distributed throughout the state. Russian-olive is originally from Europe and Asia. It was introduced to North America in the early 1900s and is found throughout Ohio. Historically these plants have been used for erosion control, strip mine reclamation, wildlife habitat, and in landscaping.

PROBLEM:

Autumn-olive and Russian-olive aggressively out-compete native plants and shrubs. They grow rapidly and re-sprout heavily after cutting or burning. Both species are prolific fruit producers, with seed dispersal mostly accomplished by birds.



Autumn-olive Division Photo

CONTROL:

Mechanical: Hand-pulling seedlings and sprouts is effective in the early spring when the ground is moist and the entire plant and root system can be removed. Other forms of control, such as mowing and burning, without the application of a herbicide usually contribute to a larger number of root sprouts.

Chemical: Systemic herbicides, such as Roundup®, Glypro®, Garlon 3A®, and Garlon 4® can be used effectively when applied to cut stumps or when used as a foliar spray. A small amount of Tordon K® in the mixture will control resprouting. Basal bark application of Garlon 4® with Penevator Basal Oil® can also be an effective form of control.

Biological: Currently there are no biological controls for Autumn-olive or Russian-olive.

ADDITIONAL INFORMATION SOURCES:

Virginia Department of Conservation and Recreation & Virginia Native Plant Society. Invasive Alien Plant Species of Virginia: Autumn-olive (*Elaeagnus umbellata* Thunberg) and Russian-olive (*Elaeagnus angustifolia* L.).

Sather, N. and N. Eckardt. 1987. Element Stewardship Abstract for *Elaeagnus umbellata*, Autumn-olive. The Nature Conservancy.

Szafoni, B. 1990. Vegetation Management Guideline: Autumn-olive (*Elaeagnus umbellata* Thunb.) Illinois Nature Preserves Commission.

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INVASIVE PLANTS OF OHIO

Fact Sheet 8

Multiflora Rose

Rosa multiflora

John Watts

DESCRIPTION:

Multiflora rose is a thorny, non-native perennial shrub with arching branches that can form dense thickets. Its compound leaves grow alternately and consist of 5-11 sharply toothed, oval leaflets. The stipules at the base of the leaf are feathery and characteristic of this plant. Multiflora rose produces many clusters of 1 inch-wide, white flowers in the late spring. Small, bright red fruits (rose hips) develop during the summer and remain on the plant throughout the winter.

HABITAT:

Multiflora rose prefers sunny areas and well-drained soils, but can tolerate a wide range of habitats. This plant readily invades open woodlands, forest edges, successional fields, savannas and prairies. Once established, multiflora rose grows rapidly forming dense, impenetrable thickets.

DISTRIBUTION:

Multiflora rose was introduced from Japan, Korea and eastern China in the 1860s as rootstock for ornamental roses. In the 1930s, it was widely promoted as a "living fence" for soil conservation and in wildlife programs. It is found throughout the United States with the exception of the Rocky Mountains, southeastern coastal plains and western desert areas. In Ohio, multiflora rose has a widespread distribution in pastures, woodlots and non-crop lands.

Division Photo

PROBLEM:

Thickets of multiflora rose can successfully displace native plant species. Multiflora rose reproduces from seed and by rooting from the arching stems. It has been estimated that an average plant produces a million seeds per year, which may remain viable in the soil for up to twenty years.

CONTROL:

Mechanical: Light multiflora rose infestations can be eradicated using a shovel, provided the entire root system is removed. For control of more severe invasions, mowing or cutting several times per growing season for 2-4 years can be effective. In some situations, a prescribed burn during the early growing season may be an appropriate method for controlling severe infestations.

Chemical: Applying systemic herbicides, such as Roundup®, Glypro®, or Garlon 4® directly to fresh cut stumps or as a basal bark application is the most effective control method. Roundup®, Glypro®, or Garlon 3A® may also be applied to the foliage.

Biological: Rose rosette disease, a natural pest on multiflora rose, was first found Ohio in 1987. Symptoms include red and purplish vein mosaics and dwarfed foliage. A virus is transmitted by a tiny mite and on average plants die within two years of infection. Efforts to introduce the disease into uninfected areas have proven difficult, but research in the area of additional biological control is ongoing and may provide a more promising control agent.

ADDITIONAL INFORMATION SOURCES:

Bartlow, J., K. Johnson, M. Kertis, T. Remaley, S. Ross, E. Simet, T. Smith, D. Soehn and G.Taylor. 1996. Tennessee Exotic Plant Management Manual. Tennessee Exotic Pest Plant Council.

Evans, J. and N. Ekhardt. 1987. Element Stewardship Abstract for *Rosa multiflora*. The Nature Conservancy.

Underwood, J.F. and E.W. Stroube. 1986. Multiflora Rose Control. Ohio Cooperative Extension Service, The Ohio State University.

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INVASIVE PLANTS OF OHIO

Fact Sheet 9

Japanese Honeysuckle & Asian Bittersweet

Lonicera japonica, Celastrus orbiculatus

Japanese Honeysuckle Division Photo

DESCRIPTION:

Both Japanese honeysuckle and Asian bittersweet are non-native, fast-growing trailing or climbing woody vines capable of covering large areas of ground or extending into the tops of trees. Japanese honeysuckle has entire, oval-oblong, opposite leaves from 1½ -3 inches long. In Ohio, the leaves are semi-evergreen, persisting late into winter or early spring. The stems are usually hairy and hollow inside, reaching a length of 30 feet or more. A profusion of 2-lipped, very fragrant, white to yellow flowers is produced in pairs in the leaf axils along the stems from April through June. The fruit is a many-seeded, black, pulpy berry maturing from September to November. Native honeysuckle vines (*L. dioica*) differ in that they bear red fruit at the ends of stems and the upper leaves of the stem are joined together. Asian bittersweet has finely-toothed, rounded, alternate leaves up to 4 inches long. The stems are round, often with noticeable lenticels, and may reach a length of 60 feet. Asian bittersweet produces numerous 5-petaled, greenish flowers that arise from the leaf axils. The fruit is a conspicuous, yellow, 3-valved capsule that splits open to reveal 3 bright orange-red seeds. The native bittersweet (*C. scandens*) can be distinguished by its elliptical shaped leaves and its flowers and fruits that arise at the tips of stems.

HABITAT:

Both Japanese honeysuckle and Asian bittersweet thrive in disturbed areas such as roadsides, fence rows, abandoned home sites and forest gaps caused by windfalls and logging. Areas of special concern are woodland edges, early successional forests, and riparian corridors. Although preferring sunny areas, both are shade-tolerant and can live in marginal habitats until favorable conditions arise.

DISTRIBUTION:

Japanese honeysuckle is native to eastern Asia and was introduced into New York in 1806 as an ornamental plant and ground cover. Now distributed over most of the southern and eastern United States, it is often planted as a source of food for wildlife. Asian bittersweet is also native to eastern Asia and was introduced into the United States in 1860 for ornamental purposes, for which it is still used in many areas. Having escaped from cultivation, it can be found over much of the eastern Midwest and Atlantic coast states. Both species are found throughout Ohio but seem to be more prevelant in the southern part of the state.

Asian Bittersweet Division Photo

PROBLEM:

Japanese honeysuckle and Asian bittersweet are aggressive growers that can severely damage native plant populations by limiting needed sunlight, constricting nutrient flow in stems, and over-weighting treetops increasing the likelihood of wind damage. Both are prolific seed producers with the seeds often being dispersed by birds. The root systems are very persistent and capable of extensive root suckering. Plants tend to regenerate quickly after cutting. These vines are often able to out-compete native species for nutrients and water.

CONTROL:

Mechanical: Hand-pulling with complete root removal is effective in small populations of both Japanese honeysuckle and Asian bittersweet. Mowing may also be effective in reducing the size of the plants, but often encourages extensive root suckering. Japanese honeysuckle may be controlled with prescribed burning.

Chemical: Chemical control of Japanese honeysuckle and Asian bittersweet may be attained using systemic herbicides such as Roundup®, Glypro®, Garlon 3A®, or Garlon 4® on cut stems or as a foliar spray. For foliar applications, the plants should first be cut to the ground and the re-sprouting foliage sprayed about 1 month later. Foliage of honeysuckle can also be sprayed in the fall or early spring when other species are dormant.

Biological: Currently there are no biological controls for Asian bittersweet or Japanese honeysuckle, although animal grazing may control the spread of Japanese honeysuckle.

ADDITIONAL INFORMATION SOURCES:

Dreyer, G. 1994. Element Stewardship Abstract for Asiatic and Oriental Bittersweet. The Nature Conservancy.

Bartlow, J., K. Johnson, M. Kertis, T. Remaley, S. Ross, E. Simet, T. Smith, D. Soehn and G.Taylor. 1996. Invasive Exotic Pest Plants in Tennessee. Tennessee Exotic Pest Plant Council.

Nuzzo, V. 1997. Element Stewardship Abstract for Japanese Honeysuckle. The Nature Conservancy.

Virginia Native Plant Society. 1995. Invasive Alien Plant Species of Virginia: Oriental Bittersweet (*Celastrus orbiculatus*).

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FS9JJ

INVASIVE PLANTS OF OHIO

Fact Sheet 10

Japanese Knotweed

Polygonum cuspidatum

Division Photo

DESCRIPTION:

Japanese knotweed is a non-native, semi-woody perennial that grows in large clumps reaching heights of 3-10 feet. The stout, hollow stems are reddish brown and the nodes are swollen giving them a bamboo-like appearance. Typical of the smartweed family, nodes are enclosed by a modified leaf-life structure. Stems die back in the winter and new ones are produced each spring. Leaves are alternate and egg-shaped (4-6 inches long and 3-4 inches wide) narrowing to a point at the tip. The tiny (1/8 inch) flowers are creamy white to greenish white and are borne in plume-like clusters in the upper leaf axils. The species is dioecious, producing male and female flowers on separate plants, however male plants are rare. Flowers bloom in August - September and female plants produce triangular, shiny black fruits, however, reproduction from seed is infrequent. This plant spreads primarily by its extensive rhizomes creating dense thickets.

HABITAT:

The species occupies a wide variety of habitats in many soil types and a range of moisture conditions. It is most common along roadsides and on streambanks, but is also found in low-lying areas, utility rights-of-way, old home sites and along woodland edges and openings. The species requires a high light environment and grows poorly under full forest canopies.

DISTRIBUTION:

Japanese knotweed was introduced from Asia as an ornamental in the late 19th century because of its unusual bamboo-like growth habit. It has been used as a landscape screening and occasionally for erosion control. It is widely distributed in the U.S., occurring in much of the Midwest and in several western states. In Ohio this species is primarily found in the eastern part of the state.

Jim Stahl

PROBLEM:

Japanese knotweed grows quickly and aggressively by extensive rhizomes and forms dense thickets that exclude native vegetation and reduce wildlife habitat. This species represents a significant threat to riparian areas where it can spread easily as small

pieces of rhizome are washed downstream and deposited to create new colonies. Transfer of soil containing rhizome or seed may also cause the establishment of new colonies. Establishment can be prevented with careful monitoring and eradication of small patches when they first develop.

CONTROL:

Mechanical: Large colonies of this species are extremely difficult to dig up due to their high rhizome densities. Digging of large colonies is not recommended as it is very labor intensive and unlikely that all below ground material can be removed. Small patches may be dug, however care should be used in removing plant material as improper disposal can spread the species further. Repetitive cutting or mowing within a single growing season to deplete stored reserves and remove photosynthetic tissue has been effective. Eradication of the rhizome system is necessary for control of this aggressive invasive species.

Chemical: Herbicide has been generally effective at controlling this species. Repetitive cutting of stems with spot application of Roundup®, Accord® or Glypro® to the stumps, and foliar spraying in large populations has been reported to be successful.

Biological: There are currently no biological controls available for Japanese knotweed.

ADDITIONAL INFORMATION SOURCES:

Seiger, L.A. 1999. Element Stewardship Abstract for *Polygonum cuspidatum*. The Nature Conservancy.

Seiger, L.A. and H.C. Merchant. 1997. Mechanical control of Japanese knotweed (*Fallopia japonica* [Houtt.] Ronse Decraene): effects of cutting regime on rhizomatous reserves. Natural Areas Journal 17(4): 341-345.

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INVASIVE PLANTS OF OHIO

Fact Sheet 11

Narrow-leaved and Hybrid Cattail

Typha angustifolia, T. Xglauca

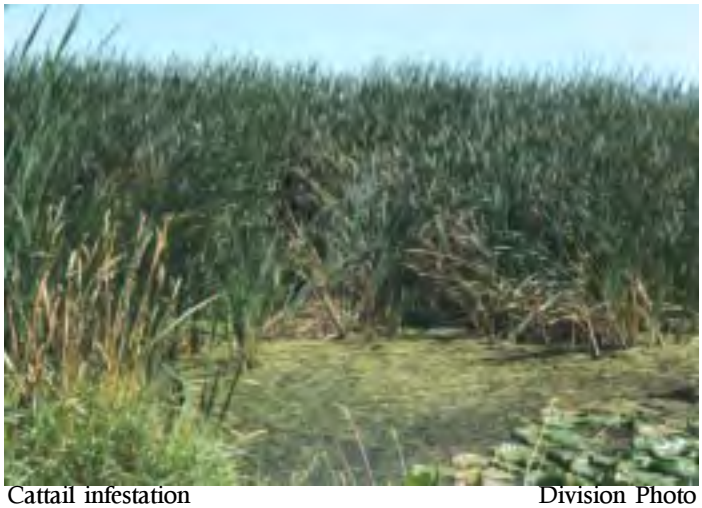
DESCRIPTION:

Narrow-leaved cattail is a non-native, invasive plant that hybridizes with the native broad-leaved cattail (*T. latifolia*) to produce the invasive *T.* x*glauca*. All three aquatic perennials may grow up to a height of 10 feet and produce a velvety brown spike of flowers. The flower head of the hybrid and the narrow-leaved cattail have a gap of 1-4 inches between the male and female flowers, while the native species has both flower types next to each other. The leaves of cattail originate from the base and spread outward. The narrow-leaved and hybrid cattails have leaves that are ¼ -¾ inch across; the native cattail's leaves are wider at ½ -1 inch. A starchy rhizome forms beneath each plant.

Narrow-leaved (Left) and Broad-leaved (Right) Cattail Division Photo

HABITAT:

Stands of cattail can be found in a wide variety of wetland habitats, including marshes, lakeshores, river backwaters and roadside ditches. This prolific plant can grow in disturbed areas, as well as brackish, and polluted waters of depths nearing 3 feet.



Cattail infestation Division Photo

DISTRIBUTION:

Narrow-leaved cattails are believed to have been introduced to the Atlantic seaboard from the dry ballast of European ships. This plant has since spread westward and occurs throughout much of the United States. The hybrid cattail is concentrated in the northeast, but may occur wherever both the native and the narrow-leaved species are present. All three taxa are found throughout Ohio.

PROBLEM:

Narrow-leaved and hybrid cattail will out-compete native plants in wetland systems. These plants establish dense monocultures that enable them to shade out native vegetation. They are also thought to be allelopathic, producing chemicals which discourage growth of other plant species. Cattails reproduce both vegetatively by rhizomes and sexually through massive amounts of seed.

CONTROL:

Mechanical: Manipulation of water levels can kill cattails by inhibiting airflow from the cattail shoots to the roots. Removing the dead leaves and submerging the shoots in early spring will eliminate gas diffusion and "suffocate" the plant. In situations where water level manipulations are either not feasible or appropriate, pulling, cutting and bulldozing treatments have been used with some success. In the case of bulldozing, the benefits in effective removal may not outweigh the costs of disturbing the wetland.

Chemical: Wick and foliar applications of systemic herbicides such as Accord®, Rodeo® or Glypro® followed by manual clipping and removal of stems can be successful. Re-treatments are usually necessary due to the extensive root system.

Biological: Currently there are no biological control methods for cattails.

ADDITIONAL INFORMATION SOURCES:

Hoffman, R. and K. Kearns, eds. 1997. Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants. Bureau of Endangered Resources, Wisconsin Department of Natural Resources.

Grace, J.B. and J.S. Harrison. 1986. The Biology of Canadian Weeds: *Typha latifolia* L., *T. angustifolia* L. and *T.* x*glauca* Godr. Canadian Journal of Plant Science 66: 361-379.

Motivans, K. and S. Apfelbaum. 1987. Element Stewardship Abstract for *Typha* spp. The Nature Conservancy.

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INVASIVE PLANTS OF OHIO

Fact Sheet 13

Smooth Brome

Bromus inermis

DESCRIPTION:

Division Photo

Smooth brome, also known as Hungarian brome, is a non-native, long-lived, herbaceous perennial. This cool-season grass can grow nearly 4 feet tall. Emerging in late March, the numerous basal and stem leaves are smooth, under ½ inch wide and up to 8 inches long. Each leaf has a characteristic "W" shaped wrinkle near its tip. From May to July, a nearly smooth stem supports the flowering portion of the plant. The flower heads are characterized by having 4-10 upright branching-spikes. Each spike is 1-2 inches long and comprised of up to 10 blunt tipped florets. The florets take on a purple-brown color as they mature from June to August and begin to set seed. Reproduction is both by seed and by its aggressive rhizomes.

HABITAT:

Smooth brome grows well in open areas such as roadsides, riverbanks, open fields and woodland edges. It is drought resistant and may go dormant during harsh conditions. It is also tolerant of periodic flooding. Open areas such as prairies, savannas, and meadows are extremely susceptible to invasion by smooth brome.

Division Photo

DISTRIBUTION:

Smooth brome was introduced to the United States from Europe and eastern Asia in 1884. It was, and still is, used as a forage crop for livestock and for erosion control along streams. It is found throughout the United States except for the extreme southeast. It is found throughout Ohio. It is most common in agricultural areas where it has escaped from its intended use.

PROBLEM:

Because of the early season growth and aggressive spread of smooth brome, it can out-compete many of the warm-season native plants found in prairies and grasslands for water and nutrients. The sod-forming roots of established smooth brome populations can prevent other species from emerging. Seeds may stay viable for up to 10 years, which coupled with its tenacious growth, makes this grass species difficult to eradicate.

CONTROL:

Mechanical: Prescribed burning after shoots emerge in late spring can help control the spread of smooth brome. This also helps favor native warm-season species of plants. However, early burning may favor the growth of smooth brome. Continual mowing can also be effective, but this normally affects non-target species as well. Control should be undertaken to prevent seed production.

Chemical: A systemic herbicide such as Roundup® or Glypro®, or a grass-specific herbicide such as Fusilade DX® can be effectively applied to dense populations in April or May. Care must be taken to avoid non-target species.

Biological: Currently there are no biological controls for smooth brome.

ADDITIONAL INFORMATION SOURCES:

Sather, N. 1987. Element Stewardship Abstract for Awnless Brome, Smooth Brome. The Nature Conservancy.

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INVASIVE PLANTS OF OHIO

Fact Sheet 14

Canada Thistle

Cirsium arvense

Division Photo

DESCRIPTION:

Canada thistle is a slender, herbaceous, non-native perennial plant reaching a height of 2-4 feet. The leaves are simple, alternate, irregularly lobed, and taper towards the tip. The underside of the leaf is normally smooth with the margin bearing many sharp spines. Stems are grooved, hairy, and branched at the top. The root system is comprised of a deep taproot that may extend 6 feet down and an extensive creeping rhizome that other thistles in Ohio lack. Numerous fragrant, lavender-pink, one-inch flowers adorn the plant from June to September. A single plant may produce up to 5,300 seeds, each of which is attached to a hair-like tuft making them easily dispersed by the wind.

HABITAT:

Canada thistle occurs in nearly every open habitat within its range and tolerates nearly any soil type that is not waterlogged. In natural areas, it is a particular problem in old fields, prairies, savannas, and early successional forests. It can also be a problem in wet sedge meadows where it invades areas above the waterline.

DISTRIBUTION:

Despite its name, Canada thistle is not native to Canada or even to North America. It is native to eastern and northern Europe and western Asia, and was introduced to North America in the 1600s. It has spread throughout all of the United States except the southeast. It is found throughout Ohio.

PROBLEM:

The extensive root system of Canada thistle allows it to out-compete and displace many native species, especially in degraded prairies where native species are not well established. Spreading both by seed and rhizome, Canada thistle can create monocultures covering large areas. The wind-dispersed seeds may remain viable for 20 years or more, allowing it to spread quickly and making it difficult to eradicate.

Division Photo

CONTROL:

Mechanical: Prescribed burning, especially in the spring, can be effective by reducing thistle density and allowing native species to compete for resources. Mowing will temporarily reduce the amount of Canada thistle, but will not kill it unless mowing is repeated often for many years - which can also harm native plants as well. Hand pulling is usually ineffective since small portions of broken taproot can easily regenerate.

Chemical: Foliar spraying of a systemic herbicide such as Roundup®, Glypro®, or Transline® is an effective control method. Fall and spring are normally the best times to treat Canada thistle to maximize the herbicide absorption into the deep taproot. Several applications will usually be needed.

Biological: There are currently no effective biological controls for Canada thistle.

ADDITIONAL INFORMATION SOURCES:

Doll, J.D. 1997. Controlling Canada Thistle. North Central Regional Extension. Publication No. 218.

Evans, J. E. 1984. Canada Thistle (*Cirsium arvense*): a literature review of management practices. Natural Areas Journal 4(2): 11-21.

Nuzzo, V. 1987. Element Stewardship Abstract for Canada Thistle. The Nature Conservancy.

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FS14JJ

INVASIVE PLANTS OF OHIO

Fact Sheet 15

Common and Cut-leaved Teasel

Dipsaxus fullonum (sylvestris), D. laciniatus

DESCRIPTION:

Teasels are non-native biennials or short-lived perennials, that grow as a rosette for a minimum of one year, send up a tall flowering stalk and then die after setting seed. During the rosette stage teasels develop a large taproot that may be over two feet in length and an inch in diameter. When flowering, teasels can reach a height of 7 feet. Both species have flowers packed in a dense oval shaped inflorescence on top of a spiny stem. Common teasel has pink or purple flowers, undivided leaves and bracts that are longer than the flowering head. Cut-leaved teasel has deeply lobed leaves and white flowers. A single teasel plant can produce approximately 3,000 seeds.

Common Teasel Division Photo

Cut-leaved Teasel Division Photo

HABITAT:

Teasels thrive in open sunny conditions in mesic to dry habitats. Cut-leaved teasel is often found in wetter soils than common teasel; both tolerate saline conditions. Teasels are commonly found in abandoned fields, along roadsides and in cemeteries. They can invade prairies, savannas, sedge meadows and moist forest openings.

DISTRIBUTION:

Teasels are native to Eurasia and northern Africa. Introductions were probably made by early settlers deliberately as ornamentals or accidentally as toys made from the flowering heads. Teasels were also used commercially for combing wool. Common teasel is distributed throughout the United States (excluding the far north central states). Cut-leaved teasel currently has a more restricted range, primarily occurring in the northeastern and Midwestern states. Both species are found throughout Ohio, although common teasel is more abundant.

PROBLEM:

Teasels produce massive amounts of seed that can remain viable in the soil for several years and have germination rates as high as 86%. In addition, the death of a mother plant leaves behind an excellent “nursery” for new seedling establishment leading to a continuous population of dense monocultures. The combination of these life history traits enable teasels to successfully out-compete native plants.

CONTROL:

Mechanical: Individual rosettes can be removed using a dandelion digger; removal of the entire root is essential to eliminate re-sprouting. Flowering stalks may be cut down once the plant has initiated flowering, but if cut too soon plants may send up new flowering stalks. It has been shown that seeds will continue to develop and mature even after cutting. To prevent seed dispersal, the cut stalks should be removed.

Chemical: Foliar application of herbicides is effective and useful when mechanical treatments are not feasible. Herbicide, such as Roundup®, Glypro®, or Transline® should be applied to the rosette stage. In natural areas, application during the late fall or early spring will result in less harm to non-targeted species.

Biological: No biological control methods are currently available.

Teasel in Fruit Division Photo

ADDITIONAL INFORMATION SOURCES:

Huenneke, L.F. and J.K. Thomson. 1995. Potential interference between a threatened endemic thistle and an invasive nonnative plant. Conservation Biology 9(2): 416-425.

Solecki, M.K. 1991. Cut-leaved and common teasel: profile of two invasive aliens. Biological Pollution: The Control and Impact of Invasive Exotic Species. Indiana Academy of Science, Indianapolis, Indiana, USA.

Werner, P.A. 1975. The Biology of Canadian Weeds: *Dipsacus sylvestris*. Canadian Journal of Plant Science 55: 783-4.

March 2001

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INVASIVE PLANTS OF OHIO

Fact Sheet 16

White and Yellow Sweet-clover

Melilotus alba, M. officinalis

Yellow Sweet-clover Division Photo

DESCRIPTION:

Both white and yellow sweet-clover are erect, herbaceous, non-native biennials that are members of the pea family. In their first year of growth, the plants are small with a smooth multi-branched stem. The leaves are alternate and divided into 3 finely toothed leaflets. The second year of growth is characterized by rapid growth of the root system and an overall bushy appearance with the plant reaching 3-5 feet tall by May. From May to September, flowers are produced on the second year plants. Flowers are borne on irregular spikes on the ends of elongated stems. Each flower spike will bear 40-80 flowers. The flowers are either white or yellow, the most obvious difference between these two species. Seed is set in summer with up to 350,000 seeds per plant.

HABITAT:

White and yellow sweet-clovers grow in open, disturbed areas such as roadsides, old fields, and utility easements. Intolerant of shade, sweet-clover invades upland habitats such as prairies, savannas, dunes, alvars, and meadows. They seem to grow best in, but are not limited to, calcareous soil. The roots of sweet-clover fix nitrogen in the soil, allowing the plants to live in nutrient poor areas.

DISTRIBUTION:

White and yellow sweet-clover are native to the Mediterranean region, central Europe, and Asia. They were brought to the United States in the 1600s as a forage crop for livestock and for honey production. They are now found in all 50 states and are used as a soil builder because of their nitrogen fixing capability. They are also often planted as wildlife cover. Both sweet-clovers are found throughout Ohio especially near agricultural regions.

PROBLEM:

The seeds of white and yellow sweet-clover have been shown to be viable for over 30 years. The plants are drought resistant and winter hardy. Because of their large size in the second year of growth, they tend to overtop and shade native sun-loving species. They are problematic in recovering prairies and savannas where they out-compete native species for water and nutrients.

White Sweet-clover Division Photo

CONTROL:

Mechanical: Prescribed burning in 2 or more consecutive years has been effective in reducing populations of white and yellow sweet-clover. However, burning in only 1 year tends to increase populations. In small areas, hand pulling of first year plants when roots are small is also quite effective.

Chemical: Spraying with systemic herbicides such as Roundup® or Glypro® can be effective. Care must be taken to prevent over-spray to non-target species.

Biological: The native sweet-clover weevil can help control white and yellow sweet-clover if the weevil is present in high concentrations. Unfortunately, this is not a reliable form of control.

ADDITIONAL INFORMATION SOURCES:

Eckardt, N. 1987. Element Stewardship Abstract for White and Yellow Sweetclover. The Nature Conservancy.

Turkington, R.A., P.B. Cavers, and E. Rempel. 1978. The Biology of Canadian Weeds: *Melilotus alba* Desr. and *M. officinalis* (L.) Lam. Canadian Journal of Plant Science 58: 523-537.

March 2001

FOR MORE INFORMATION:

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INVASIVE PLANTS OF OHIO

Fact Sheet 17

Tree-of-Heaven

Ailanthus altissima

DESCRIPTION:

Tree-of-heaven is a rapidly growing non-native tree that reaches a maximum height of about 80 feet. The bark is gray to brownish-gray, often turning nearly black with age. Twigs and stems range from light to dark brown. The leaves are pinnately compound with 11-41 leaflets. Each leaflet has an entire margin except for 1-5 small gland-tipped teeth near its base. In late spring, tree-of-heaven produces dense clusters of small, 5-6 petaled, yellow-green flowers near the ends of the upper branches. Seeds develop in the fall and may remain on the tree throughout the winter. Each seed is borne in the middle of a twisted, flattened, wing-like structure. The wood is light in color and weak, rotting quickly when dead. Leaves and young stems have an unpleasant odor that resembles rancid peanut butter. Care should be taken in identification to avoid confusing tree-of-heaven with native species such as walnut and sumac.

Division Photo

HABITAT:

Tree-of-heaven can be found in nearly any habitat except wetlands. It thrives in disturbed soils in both urban and natural areas. In natural areas, tree-of-heaven invades fencerows, roadsides, woodland edges, successional forests, and open forest thickets. Tree-of-heaven thrives in poor soils and tolerates pollution well, a reason why it is often planted in urban areas.

DISTRIBUTION:

Tree-of-heaven was introduced to the United States from China. It was first brought to Philadelphia as a garden plant in 1784. By the mid 1800's, it was well established as a nursery tree because of its ability to grow nearly anywhere. Chinese immigrants that came to the United States to work in the gold mines also introduced it to California as a medicinal plant. Absent only from the northern plains of the United States, tree-of-heaven is found throughout Ohio. It poses the greatest threat to successional forest areas of Ohio.

PROBLEM:

One mature tree-of-heaven can produce up to 350,000 seeds per year. These seeds are easily airborne and can be transported by water and birds as well. Germination of seeds is quite high. Mature trees also reproduce extensively by sending up root suckers and sprouts from cut stumps. Sapling growth can reach 3-4 feet a year and can outgrow nearly any native tree, out-competing natives for light. The roots give off a toxin that acts as a herbicide that can kill or inhibit the growth of other plants. Tree-of-heaven is somewhat shade-tolerant and can grow quickly when released by gaps in the forest canopy caused by windfalls, logging or defoliation due to insect pests such as gypsy moth.

Tree-of-Heaven in the understory Division Photo

CONTROL:

Mechanical: Young seedlings may be successfully hand-pulled if the entire root system is removed. If small portions of the root system are left, regeneration is likely. Cutting alone is usually not effective since this merely stimulates aggressive root suckering and stump sprouting. However, cutting large trees can help control its spread by removing seed-producing trees.

Chemical: It is of utmost importance to kill the entire root system. Systemic herbicides such as Roundup® or Glypro® may be effective as a foliar spray on seedlings. For larger trees, cut stump treatment or basal bark application using a systemic herbicide such as Garlon 4® is best especially if treated in late winter or late summer. Using a small amount of Tordon K® with the Garlon 4® mixture will increase success of basal bark or cut stump application, but care must be used as Tordon K® can translocate from the root system of the target tree and kill non-target plants.

Biological: No biological controls are currently available.

ADDITIONAL INFORMATION SOURCES:

Hoshovsky, M. 1999. Element Stewardship Abstract for Tree-of-Heaven. The Nature Conservancy.

Bartlow, J., K. Johnson, M. Kertis, T. Remaley, S. Ross, E. Simet, T. Smith, D. Soehn and G.Taylor. 1996. Invasive Exotic Pest Plants in Tennessee. Tennessee Exotic Pest Plant Council.

March 2001

FOR MORE INFORMATION:

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Appendix C

Field Standard Operating Procedures

ENVIRON

STANDARD OPERATING PROCEDURE
FOR

THALES HANDHELD GPS UNIT OPERATION

SOP 1024

DATE: NOVEMBER 20, 2006

REVISION: 0.0

Prepared by: _____ Date: 11/21/06
Michael J. Ferguson

Reviewed by: _____ Date: 11/21/06
Katrina B. Leigh

Approved by: _____ Date: 11/21/06
Timothy R. Barber

C O N T E N T S

P R O C E D U R E S

1.0 Scope and Application

1.1 This standard operating procedure describes the methods to be followed to operate the Thales handheld GPS unit.

1.2 The purpose of this procedure is to ensure a uniform method of collecting geographic location data.

2.0 Summary of Method

2.1 At each location of interest, the GPS unit is used to collect and save geographic location data from GPS satellites.

2.2 Data is uploaded from the GPS unit onto a computer and incorporated within GIS software.

3.0 Definitions

3.1 GIS – Geographic Information System

3.2 GPS – Global Positioning System

3.3 HASP – Health and Safety Plan

3.4 HAZWOPER – Hazardous Waste Operations and Emergency Response

3.5 OSHA – Occupational Health and Safety Association

3.6 PDOP – Position Dilution of Precision

3.7 PPE – personal protective equipment

3.8 SOP – standard operating procedure

3.9 USB – Universal Serial Bus

4.0 Health and Safety

4.1 Review the site-specific HASP prior to conducting any procedures described in this SOP.

4.2 As dictated by the site-specific HASP, wear appropriate PPE when working with potentially hazardous materials and/or potentially hazardous environments.

4.3 Be aware of slip, trip, and fall hazards while operating GPS unit and traversing the site.

5.0 Personnel Requirements

5.1 All involved personnel must be 40-hour OSHA HAZWOPER certified (29 CFR 1910.120).

5.2 All involved personnel must be in compliance with the ENVIRON global Health and Safety Plan.

5.3 All involved personnel must be in compliance with any site-specific requirements.

6.0 Potential Equipment and Supplies

- Thales Mobile Mapper CE handheld GPS unit
  - Microsoft® Windows® CE
  - ArcPad® 7
  - I/O module
  - USB data cable
  - AC adaptor
- Stylus
- Removable SD card for GPS unit
- USB data cable
- Field notebook
- Waterproof pens/markers
- Stakes
- Flagging tape

7.0 Overview of GPS unit

7.1 The GPS unit runs on a Windows® CE operating system designed for small handheld computers. The system is operated by tapping on the touch screen with the stylus.

7.2 Text may be incorporated into the system by using the integrated alphanumeric keypad on the GPS unit or the on-screen keypad.

8.0 Pre-Mobilization Methods

8.1 Fully charge the removable/rechargeable internal battery of the GPS unit prior to arrival in the field. *A fully charged battery should provide ample power for a full working day.*

8.2 If desired and available, aerial or satellite images (*.jpg) and geo-referencing data (*.jgw) can be uploaded to the appropriate project file set up within the GPS unit using Microsoft® ActiveSync® and the USB data cable.

9.0 Field Methods

9.1 Turn on the GPS unit by pressing the red power button.

9.2 Open ArcPad® from START MENU by selecting Programs>ArcPad 7.0.

9.3 Open existing map file (*.apm) or create a new empty map and save within the appropriate project file directory.

9.4 If existing map file and editable shapefile (*.shp) exists, then select the Table of Contents icon () from the main toolbar to set the layer properties. Add new layers by selecting the Add Layer icon () and browsing for the desired layer or adjust the visibility () of existing layers. Be sure the desired field location data shapefile (*.shp) is selected as the only editable layer ().

If a new map is created, create a new shapefile (*.shp) by selecting the dropdown arrow to the right of the Open Map icon (). From the dropdown menu, select, New>Shapefile. Select the + button to open the Field menu, rename the field, and select OK. Select OK from the New Shapefile menu and save within the project file. When prompted to create a QuickForm, select No.

9.5 Activate the GPS receiver, by selecting the dropdown arrow to the right of the GPS Position Window icon (). From the dropdown menu, select GPS Active and Yes when prompted. Wait for the GPS unit to receive data as indicated by the GPS cursor displayed with yellow crosshairs.

9.6 At the location of interest, capture geographic location data by selecting the GPS Point icon (). From the Feature Properties menu, identify the location by selecting the field name, entering a location ID, and selecting OK. *Allow GPS fix averaging to complete (i.e., reach 100%) as indicated in the menu title before selecting OK.*

9.7 Save the shapefile (*.shp) and associated layers by selecting the Save Map icon ().

10.0 Post-Demobilization Methods

10.1 Upload desired shapefile (*.shp), shapefile database file (*.dbf), and shapefile index file (*.shx) with Microsoft® ActiveSync® and USB data cable for use in GIS platform.

11.0 Decontamination Methods

11.1 No decontamination methods are necessary.

12.0 Quality Assurance/Quality Control

12.1 Maximum PDOP values of 6 are acceptable, while values less than 2 are considered “good.” Alerts will be set up to warn the user when the maximum

PDOP value of 6 is exceeded by selecting the dropdown arrow to the right of the GPS Position Window icon () and GPS Preferences from the dropdown menu. Within the Quality tab, choose Non-compulsory Warnings (prompts option of ignoring quality settings) or Compulsory Warnings (enforces quality settings).

12.2 If maximum PDOP values are exceeded, locations will be staked and labeled for later data capture.

13.0 References

13.1 ESRI. 2005. ArcGIS® 9: Using ArcPad®. ESRI Incorporated.

13.2 Thales. 2005. MobileMapper™ CE: Getting Started Guide. Thales Navigation.

Appendix D

Herbicide Application Approval Letter

-----Original Message-----
From: John Estenik [mailto:John.Estenik@epa.state.oh.us]
Sent: Tuesday, March 17, 2009 9:59 AM
To: Jen Lyndall
Subject: Re: Pesticide application - Middletown, Ohio

I have reviewed your request to apply herbicide to invasive species in the flood plains of Dicks Creek and a portion of Monroe Ditch in Middletown, Ohio. I do not see any problem with your request as stated. Applications of the identified herbicide applied according to label instructions can occur through December 2009.

>>> "Jen Lyndall" <jlawton@environcorp.com> 3/13/2009 5:37 PM >>>
Hi John,

We are planning to implement floodplain soil and sediment remediation and restoration under a Consent Decree signed by the United States, State of Ohio, Natural Resources Defense Council, Sierra Club, and AK Steel (Case Number C-100530). The remediation and restoration activities are located in and adjacent to Reach 1 of Dicks Creek and a portion of Monroe Ditch in Middletown, Ohio (see attached map). Following restoration implementation, spot herbicide applications may be necessary to control invasive species (e.g., reed canary grass, Phragmites, purple loosestrife) and allow the planted native vegetation to become established. It is anticipated that Rodeo will be applied to individual plants within the floodplain during the summer and/or fall 2009, as needed. The certified pesticide applicator in the State of Ohio will apply the herbicide using a backpack applicator or a vehicle mounted tank with wand sprayer. No herbicide will be applied to surface water (or drinking water sources). No protected or endangered species are likely to be affected.

Please feel free to contact me if you have any questions or if you need additional information.

Thanks,

Bruce Patterson